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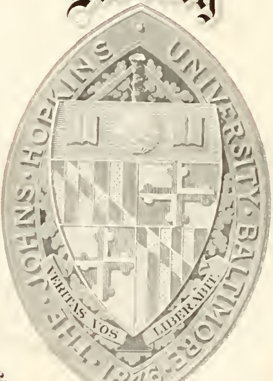

Johns Hopkins of the University

THE EFFECTS OF CIGAR AND CIGARETTE SMOKING ON CERTAIN PSYCHOLOGICAL AND PHYSIOLOGICAL FUNCTIONS

BY

ROBERT LEE BATES

A dissertation submitted to the Board of University Studies of the Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy

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THE EFFECTS OF CIGAR AND CIGARETTE SMOKING ON CERTAIN PSYCHOLOGICAL AND PHYSIOLOGICAL FUNCTIONS[1]

ROBERT LEE BATES

From the Psychological Laboratory of the Johns Hopkins University

I. DART THROWING

1. *Apparatus and methods*

In preliminary work on the effects of tobacco smoking on accuracy in dart throwing,[2] Carver found indications that smoking caused a decrease in accuracy of throwing, within a short period after the smoking. On account of the relative smallness of the indicated effect, and the negative results of tests on certain other functions under smoking conditions, it was important that this evidence should be fully checked by further work.

The work here reported was accordingly undertaken in the Fall Semester of 1920 under Professor Dunlap's direction. The apparatus (targets and darts) used by Carver was employed. The "Apex" darts (see fig. 9) were the same as those used by Buford Johnson in her original dart-throwing experiment,[3] but the target was Dunlap's modification of Johnson's target.

The target foundation consisted of seasoned wood upon which was glued sheet cork of 1 inch in thickness and 3 feet square. The cork made an excellent medium for the penetration of the points, as the darts could be easily removed, and owing to its pliability, the deterioration of the backing was reduced to a minimum.

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[1] The expenses of this research were in part defrayed by the committee to study the tobacco problem, but the responsibility for the planning and execution of the work, and for the conclusions, rests solely with the author and Professor Dunlap.

[2] Carver, D. J.: The immediate psychological effects of tobacco smoking. Journal of Comparative Psychology, 1922, ii, 279–302.

[3] Johnson, B.: Practice effects in a target test: A comparative study of groups varying in intelligence. Psychological Review, 1919, xxvi, 302–303.

A master target (see fig. 8) was made on tracing cloth and from this a number of blue-print targets were reproduced. When the targets began to show depreciation from continued pricking, they were easily replaced by gluing a new target over the old one. The target consisted of a blue field with white rings and white cross lines. There was a central white disc of $1\frac{1}{4}$ inches in diameter. The succeeding discs had radii of 3, 6, 9, 12, and 15 inches[4] respectively with $\frac{1}{8}$-inch rings of demarcation. The target bore both a vertical and a horizontal cross line, white, $\frac{1}{8}$-inch in width, each extending from edge to edge of the target sheet, and intersecting at the center of the bull's eye. These divided the target into four quadrants, enabling the examiner to estimate whether the reactor was undershooting or overshooting the mark, as well as to ascertain to what extent he was banking his hits to the right or to the left of the vertical dividing line. These lines at the same time destroyed the illusion of a tunnel which resulted from unbroken concentric rings and which was a source of annoyance to the reactor.

The target was supported vertically, with the center of the bull's eye 61 inches from the floor, and with its vertical plane 15 feet from the reactor's "toe line." Illumination was secured from a 60 candle power nitrogen filled mazda lamp placed obliquely at a suitable distance from the target, with a metal reflector which shielded the reactor's eyes from the direct light.

The daily and hourly schedules of reactors are shown in tables 1 and 2. The hour for conducting tests was accommodated to the study program of the several reactors, they being undergraduate students in the University. In so far as was possible, each reactor worked on the same hour on each of his days.

In order to obviate stage fright, self consciousness and other personal disturbances, a practice period of seven days was allowed to reactors working under schedules 1 and 2. On these practice days the reactor refrained from smoking in the part of the day preceding the giving of the test. Alternation of smoking and non-smoking at this time might have well been undertaken in order to study the learning abilities when smoking and when not smoking. Failure to do so, however, had no bearing upon the test as it was presented and evaluated.

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[4] In Carver's article, page 294, the diameter of ring 2 is given as 29 inches, which is a clerical error, 24 inches being the actual measurement.

TABLE 1

Distribution of working days of the individual reactors

The numbers indicate the schedules of the different days

DATE	REACTORS					
	1	2	3	4	5	6
October 6	1					1
October 7	1		1		1	1
October 8	1	1	1		1	
October 9	1		1			1
October 11		1		4	1	1
October 12		1		4	1	1
October 13	1		1	4	1	1
October 14	1	1	1		1	1
October 15	1	1	1		1	
October 16	1		1			1
October 18		1		4	1	2
October 19		1		4	2	1
October 20	2		1	4	1	2
October 21	1	1	2		2	1
October 22		2	1		1	
October 23	2		2			
October 23		1		5	2	
October 26		2		4	1	2
October 27	1		1	5	2	1
October 28	2	1	2		1	
October 29	1	2	1		2	
October 30			2			
November 1		1		4	1	2
November 3	2		1	5	2	1
November 4	1	2	2		1	2
November 5	2	1	1		2	
November 6	1		2			1
November 9		2				
November 10	2		1		1	2
November 11		1	2			
November 12	1	2	1		2	
November 13	2		2			
November 15		1		4	1	
November 16		2		5	2	1
November 17	1		1	4	1	2
November 18	2	1	2		2	1
November 19	1	2	1			
November	2		2			2
November 22		1		5		1
November 23		2		4		2
November 29		1		5		
November 30		2		4		1
December 1	1			5		2
December 2	2					

In conducting the test after the smoking was introduced, non-smoking days and smoking days were allowed to alternate until ten days of each had been concluded, making in all twenty-seven days for each reactor.

After reaching the laboratory, the reactor remained seated from fifteen to twenty minutes preceding the throwing of darts. On the non-smoking days this constituted a rest period, and on smoking days it provided the interval in which reactor smoked. In this manner the time of the throwing was kept at a near constant—thirty to thirty-five minutes. Upon the word "set up" the reactor took a position "toeing" a line 15 feet from target, and grasped in the left hand 13 darts, taking them from a table placed at his left, and waited for the word "go." At "go" he began throwing the darts at the target with the rate and force which seemed to him most suitable. As soon as he had thrown the 13 darts, he took 12 more from the same table, and continued throwing until these were gone. By this method the reactor's attention was distracted but once from the bull's eye. All darts remained where they stuck in the target until the set of 25 had been finished and scored.

TABLE 2

Working hours of the reactors

Fifty minutes, beginning at the hours indicated

Reactor 1	Wednesday, Thursday, Friday, Saturday, 9:30
Reactor 2	Monday, Tuesday, 9:30; Thursday, Friday, 10:30
Reactor 3	Wednesday, Thursday, Friday, 8:30 ; Saturday, 10:30
Reactor 4	Monday, Tuesday, Wednesday, 10:30
Reactor 5	Monday, Tuesday, Wednesday, Thursday, Friday, 2:00
Reactor 6	Monday, Tuesday, Wednesday, Thursday, Saturday, 3:00

The first day of throwing, the reactor was told to confine himself to overhand throws, and to hold the dart in such manner as seemed to him to conduce to accurate throwing. In every instance the reactor chose to grasp the dart between the first two fingers and thumb, close to the metal socket of the point. This method of throwing was continued throughout the tests.

The experimenter scored the darts as they were thrown by noting the circle in which the hits fell, the bull's eye being scored

6 and the succeeding circles scored as 5, 4, 3, 2, and 1. All hits without the outer circle were scored 0. When the experimenter was in any doubt concerning the accuracy of the scoring, a recount was made at the end of the set. The darts were then withdrawn by the experimenter, who, as he withdrew them, scored the hits in the four quadrants.

Two minutes of rest (reactor seated), were allowed between each of the daily 12 sets of throws of 25 to the set. This method was used instead of a "headway" of a certain number of minutes, as employed by Carver, in order to have a definite time for scoring a set and collecting the darts for the next set. However, as the test worked out, the "headway" was fairly constant at from two and one half to three minutes. There was but a difference of a few seconds between the average throwing time of the different reactors, with the exception of reactor 4.

Six reactors were employed in the test, 5 of them for twenty-seven days each on schedules 1 and 2, the other (reactor 4), for nineteen days on schedules 4 and 5.

From the outlines of the individual's "observable characteristics," it may be said that the 6 reactors were apparently mentally normal young men. With continued observation of the reactors and their performances, certain traits which might be considered by some theorists as "neurotic" became evident. Such traits would be found in every intelligent individual under continued observation.

The tests occurred in a quiet room, no one being present except the reactor and the experimenter. Daily records were kept of the temperature and humidity in the room, and records of barometric pressure were obtained from the Baltimore station of the Weather Bureau. A study of these records revealed nothing which could account for variations in the performance, and hence the records are not here inserted.

2. The regulation of smoking in connection with the tests

Under schedule 1 the reactor refrained from smoking in the portion of the day preceding the giving of the test, and did not smoke for the test.

Under schedule 2 the reactor refrained from smoking each day preceding the giving of the test, but smoked one cigar or two cigarettes in the fifteen or twenty minutes immediately preceding the throwing of darts, other conditions remaining the same as under schedule 1. Cigars and cigarettes were not alternatives, but each reactor confined himself to the one or the other.

Under schedule 4, the reactor, (a habitual smoker) did not refrain from smoking but continued his use of tobacco as usual. He smoked before coming to the laboratory but not thereafter.

Under schedule 5, the reactor desisted from smoking on the day of the test and did not smoke for the test.

In every case from beginning to end of reactor's daily performance, the duration was approximately fifty minutes.

Schedules 1 and 5 may at times in this inquiry be referred to as non-smoking test days, and schedules 2 and 4 referred to as smoking test days. In the case of reactors 1, 2, 3, 5, and 6, schedule 1 was followed for the first seven (practice) days, and thereafter schedules 1 and 2 were followed on alternate days. For reactor 4, schedule 4 was substituted for schedule 1, and 5 for 2.

The cigars used were of a commercially well known brand, made in Baltimore, of claro-colorado strength, retailing at 10 cents. They were of practically the same grade as the cigars used by Carver, but were not the same brand, the size and strength desired being temporarily unobtainable in the former brand. The cigarettes were of a popular brand, running very uniform in strength.

The amount of tobacco smoked by each reactor in each smoking day was estimated by the procedure described below. Although, as Carver has pointed out, such attempted standardization has little significance, it was thought well to keep the record. It must be distinctly understood, however, that we do not assume that the quantity of smoke products absorbed by the reactors varies simply with the quantity of tobacco burned. Nor do we assume that the weights give exactly the actual amount of tobacco, since in spite of our attempts to keep the cigars uniformly moist in the humidor, the moisture undoubtedly varied.

Fifty cigars of the type and kind used for tests were stripped of their trade-mark bands and weighed. The weighing took place immediately upon the breaking of seals and removal from the box. The average weight of a cigar was found to be 5.9267 grams. The fifty cigars were next placed one at a time upon the balance; and the one weighing nearest to the average weight was selected. The first (pointed) inch of this cigar was cut off and weighed, its weight being 1.11 grams. The next inch, more or less constant in its cylindrical form, was then cut off and weighed. This was found to weigh 1.405 grams. The weight per $\frac{1}{8}$ inch of the cylindrical part was then: $\frac{1.405}{8} = 0.1756$ gram.

When conducting the tests the portion of each cigar unsmoked at the conclusion of the interval for smoking was measured to the eighth of an inch, and the weight of the tobacco smoked thus estimated. The deviations due to the slightly different weights of individual cigars are too small to be considered.

Sixty cigarettes were in like manner weighed and the average computed to be 1.1408 grams per cigarette. The cigarette being of a uniform cylindrical shape, the smoked portion was determined in a manner simpler than that for the cigar. No deduction was made for the paper wrapper.

The approximate weights of tobacco smoked by each reactor on each of his smoking days are given in table 3.

3. Personal notes on the six reactors

The reactors were undergraduate students in the University, and were representative types, so far as intelligence, scholarship and general health are concerned. The experimenter not only controlled the work of these men during the dart-throwing periods as carefully as possible, making the daily routine uniform, but also obtained daily information on the state of health, sleep and general activities of each man, and kept watch of their behavior throughout the experiment, for indications of emotional peculiarities and changes. Each man was interrogated as to his own beliefs and attitudes concerning the use of tobacco, in order that any possible effect of bias upon the man's endeavor might be noted. The net result of the observations and interrogations which are reported below was to convince the experimenter that the 6 reactors were "normal," and were coöperating fully with the experimenter.

TABLE 3

Smoking schedules of reactors, indicating grams of tobacco consumed for each day's test

DATE	REACTOR 1 (CIGARETTES)	REACTOR 2 (CIGARETTES)	REACTOR 3 (CIGARS)	REACTOR 5 (CIGARS)	REACTOR 6 (CIGARS)
October 18					4.46
October 19				4.81	
October 20	1.65				3.41
October 21			3.06	4.11	
October 22		1.65			
October 23	1.65		4.11		
October 25				3.58	
October 26		1.71			2.00
October 27				3.76	
October 28	1.40		3.93		
October 29		1.65		4.11	
October 30			3.58		
November 1					3.41
November 3	1.45			4.64	
November 4		1.55	3.93		3.58
November 5	1.60			4.11	
November 6			4.46		
November 9		1.65			
November 10	1.71				4.11
November 11			4.46		
November 12		1.71		5.16	
November 13	1.55		3.58		
November 16		1.65		4.81	
November 17					3.58
November 18	1.71		4.11	4.81	
November 19		1.65			
November 20	1.65		4.11		4.11
November 23		1.65			4.46
November 30		1.65			
December 1					3.76
December 2	1.50				

It must be distinctly understood that while the statements as to the reactors smoking habits are, in substance, the reactors' own reports on the matter, the summaries of the reactors' temperamental, emotional, and motor characteristics are the experimenter's opinions, based on daily observations and on information informally elicited from the reactors during the preliminary 'resting' or smoking period. While the summaries indicate divers temperamental tendencies, they are all such as may be expected concerning normally healthy young men.

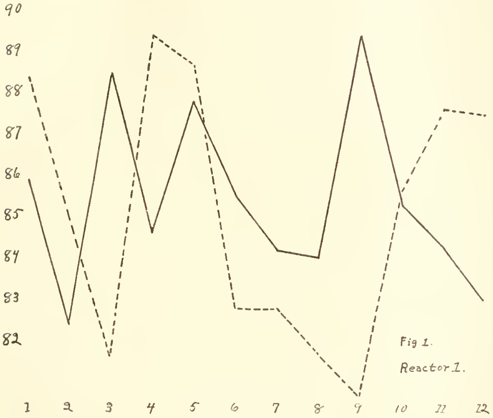

FIG. 1

Reactor 1. Age nineteen years, ten months.

This reactor smoked his first cigarette about three years ago. He then smoked at intervals for a short while and discontinued the use of tobacco for about a year and a half. At present he smokes only when with his associates, and then for mere sociability. He states that he does not enjoy smoking, and feels that it is injurious to his health. He is an expert swimmer and refrains from the use of tobacco when making trials or entering contests, as he is of the impression that his breath is shortened from its use. He states that he has formed no habit, as he has no difficulty in discontinuing smoking whenever he desires. Reactor does not inhale the smoke.

Reactor 1 developed a tendency to ennui as the tests progressed. At times he seemed capricious in his throwing, changing his rate and his speed without apparent reason. This was noted on a number of occasions, but on October 29 and November 4 and 5 particularly. He maintained throughout the tests a recurring disposition to experiment with his own throwing. On October 16, after a good set of throws, he announced, "I am going to make a record." The next hit fell in an outer circle after which he began to throw in a somewhat haphazard manner. At the conclusion of the test he volunteered that when he "went wild on the first throw" it was difficult to continue his throws thereafter with accuracy. The reason he gave was "he just got discouraged." No other emotional or temperamental reasons were evidenced that might affect his precision in throwing than have already been noted.

Reactor 2. Age twenty-one years, ten months.

This reactor smoked for the first time at nine years of age. He has not been an habitual smoker. When in military training at Plattsburg in the summer of 1918, he smoked from five to six cigarettes a day. In the Student Officers Training Corps, in the fall of 1918, he continued smoking but at this time began using a pipe. On one occasion he was made sick from its use. After this he discontinued smoking altogether and has not used tobacco since, excepting for the tests as are here described. He has never tried to inhale tobacco smoke.

Reactor 2 seems to entertain no prejudice as to smoking in general. He admits that he personally enjoys it. He does not approve of drastic legislation in regard to smoking, but favors such legislation as the West Virginia smoking laws, where, under the law, no person under sixteen years of age is allowed to smoke and no one under twenty-one years is permitted to smoke a cigarette.

In the dart-throwing tests, reactor 2 at first appeared to be ill at ease or easily embarrassed, but for the greater part of the experiment he was quite at ease. Trivial things at times seemed to distract his attention from his throwing, much to the detriment of his aim. On October 15 the reactor in several throws at the beginning of the test threw wide of the mark. Thereafter he seemed to lose control of the darts. It seemed to be an accident if he approached the center of the target.

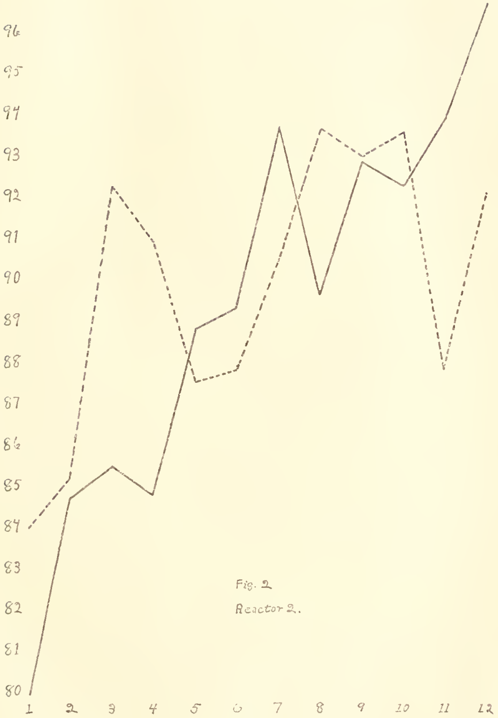
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Fig. 2
Reactor 2.

FIG. 2

Some of the darts stuck in the floor as close as 10 feet from the reactor. The hits seemed to be confined to no one quadrant, but the tendency seemed to be to the lower left. While the test was in progress, the reactor laughed hysterically at his inability to control his aim. He ventured the statement at the time, "When I make a wild throw I cannot get my eye off of that dart." Before the end of the period he had regained his former control. This incident is related in detail as the same condition manifested itself on October 19, 22 and 26, and for other intervals of but short duration.

Reactor at times seemed to be affected by a depression which he characterized as "the blues," and which at times would give way to high spirits or exuberance. October 18, reactor stated that he was feeling dejected. This he attributed to the weather, it being rather close and oppressive and somewhat foggy. The thermometer stood at 76°. On October 19 reactor still indicated a feeling of dejection and at the conclusion of the test, when a cause for this was requested, replied that "everything looked so hopeless" to him. Upon questioning him at the close of the tests, the reactor stated that is he more at ease with one individual than he is with a crowd. In a crowd he states that "he is lost." He bites his lips when under stress or strain in order to compose himself. He states that he forces himself into situations and in recent months has discovered that he reacts with considerably more self-composure. He is susceptible to worrying at slight provocation, has a vivid imagination—"too vivid"—and at times has feelings of irritability. He is exceedingly sensitive, his particular dread seems to be that some one may impeach his honesty or impute to him improper motives in conduct. He used to have feelings that he was being depreciated or disparaged by his associates but at present feels that he is overcoming this condition. He formerly preferred to be alone but has forced himself into situations until he feels that he has become more sociably inclined.

Reactor 3. Age eighteen years, eight months.

Reactor 3 smoked for the first time at nine or ten years of age. He began with corn silk and the like and gradually took up tobacco. Since July last he has been an habitual and regular smoker. Prior to that time he indulged occasionally, in his own words, "when he felt bad and bold," and then he used cigars or pipe. As a rule he has never been a cigarette smoker. He alleges his chief reason for indulgence is "to occupy his time." He states he never uses tobacco during school hours but smokes a pipe before and after the day's classes, and smokes a pipe while he studies of an evening. This reactor can inhale tobacco smoke into his lungs.

This reactor seemed to entertain no feeling against either smoker or non-smoker. He stated that he would desire to have his or others' privileges respecting the use of tobacco neither restricted nor relaxed by legislation.

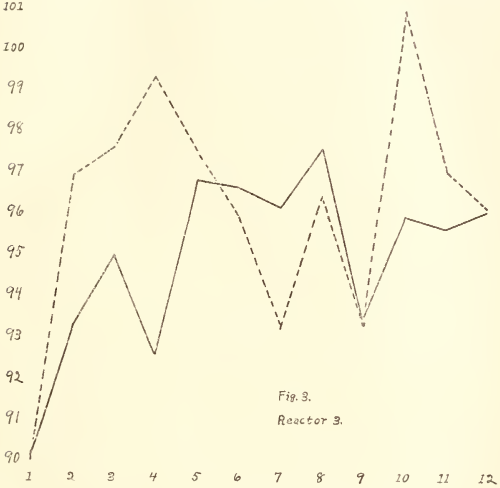

FIG. 3

Reactor 3 manifested throughout the tests a fidgety, restless disposition and was inclined to be somewhat garrulous. His restlessness took the form of repeatedly shifting his position in his seat while the darts were being counted for the succeeding test. He was usually alert and responsive at the command to begin throwing. He frequently hugged his knees as he sat. While he maintained this tendency throughout the giving of the tests, the trait was particularly noticed on October 20 and 30. He has a light-hearted and genial disposition and possibly attaches much weight to his own conduct and utterances. During his early practice days he was inclined to put a kind of physical contortion into his throws—a "winding up", in baseball parlance. He leaves the impression of possessing a type of abandon which gives a spontaneity to his actions and his utterances. On several occasions he whistled a tune as he threw (seventh set of October 22, and third and fourth sets of October 23). He usually anticipated the words "set up," and even the word "go." This was first noted October 20 and the trait persisted throughout the entire performance of the tests. He kept a mental account of his hits—even to the point of a keen competition with himself. October 29 and November 10 were noted as possible exceptions. He strove to exceed his former records and expressed chagrin upon his failure to obtain his desired success, this particularly when his first throw or throws went wide of the bull's eye. He stated on one occasion October 29, that he was nervous but could give no adequate definition of what he meant by the term, excepting mental and physical restlessness. In his words, he "cannot stick to one thing for a long time," and, as he further states, has a lack of ability to accomplish a thing through tedious effort. For the period of the tests a feeling of well-being or exuberance seemed to be his characteristic mood.

He has had some five operations performed upon his throat and nose for the removal and treatment of tonsils and adenoids. These operations were performed between his fourth and fifteenth years of age.

Reactor 4. Reactor 4 began smoking at the age of thirteen. He took up tobacco by way of corn silk, fine wood shavings and the like. He smokes at present from six to ten cigarettes daily. He never smokes cigars and seldom smokes a pipe. Cigars give him a headache and too many cigarettes produce a feeling of oppression about his head. He smokes, as he alleges, because he "enjoys it." He has discontinued his habit for as much as two months at a time, the last about a year ago. He states that he never thinks of smoking so long as his attention is distracted from it or where he knows it is impossible to smoke.

This reactor insists that adults may smoke, but that the use of tobacco should be denied to those who have not reached physical maturity, and designates eighteen as the approximate age of maturity.

Throughout the tests the reactor maintained a slow, deliberate rhythm in throwing his darts. This was possibly due to throwing over the wrong foot (right). He never learned to throw in any other manner. The duration of time for throwing sets of 25 was materially lessened towards the end of the tests. The reactor has a quiet, unassuming manner and is inclined to neatness in his general physical appearance. He states he is of a nervous temperament. In childhood he alleges he was easily made to cry, the cause being that others regarded his endeavors with indifference. The taking of an activity out of his hands, or displacing him in any way, caused a resentment on his part. At the present time these feelings persist. His feelings of greatest dejection are produced by some one "throwing cold water" on his activities. In viewing motion pictures he formerly was unable to witness the exciting parts, and repeatedly found himself closing his eyes until a happier progress was presented. The reactor admits that he is given to "building air castles" and to daydreaming. He encounters difficulties when he is required to act out of concert with others and complains of a stage fright in which his flow of speech is impeded. He states he has a persistent dream of a "barrel" that grows in size and

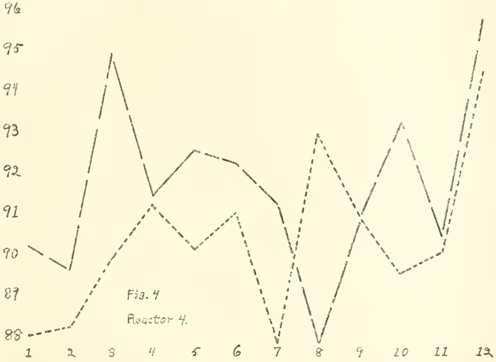

FIG. 4

from which he escapes with difficulty as it rolls along. At times in his sleep he has a feeling that his legs are tied and when he calls for help is unable to utter a sound. These conditions might seem to indicate a state of self-consciousness in conjunction with a sense of inadequacy or inferiority. The reactor alleges that he felt composed throughout the dart-throwing tests.

Reactor 5. Age eighteen years, six months.

This reactor smoked for the first time in December, 1919, being at a club meeting when cigars were passed around. After that he averaged about one cigar a month. The past summer he smoked about one cigar a week. Home influences were against the use of tobacco. Since October he has been continually increasing his amount of smoking. At the present time he sometimes smokes several cigarettes a day. Formerly he smoked for sociability; at the present time it is a source of enjoyment. He inhales somewhat. He sees no reason why adults

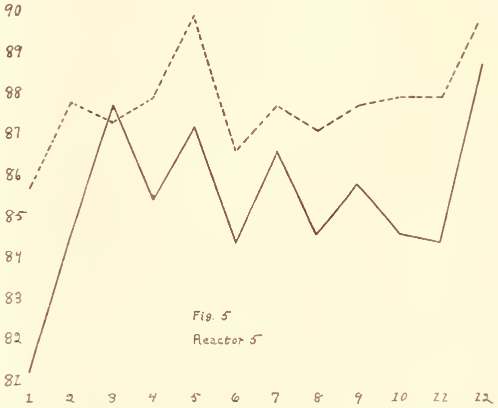

Fig. 5

should not smoke if they desire to. He states that the best grades he has made in his studies have been since he has become a regular smoker.

The reactor maintained throughout the tests his disposition to throw the darts in as rapid succession as was possible with consistent aiming. He attained the point where he could make 25 throws, with interval for grasping the latter 12 included, in thirty-three seconds. He kept his impulsive force, according to close observation, at nearly a constant. Combining a nearly constant rapidity of throwing with a nearly constant force injected a factor into the throwing that makes his results of considerable significance when compared with the results of others. Reactor is alert and quick of both perception and reaction. This seems to be borne out in his rapidity of speech and in the quickness of his stride. He is the possessor of a prize scholarship and does well in his classes.

He gave a history of a paroxysmal contraction, of two years ago, of the muscles of his back, and stated that he was of the impression that his (few) wide throws to the lower-left were due to a muscular contraction of his arm. He stated that his knee reflexes were unequal, but upon examination the examiner could find no inequality. Reactor did have a very fine muscular tremor of his fingers.

The reactor stated that he observed a difference in the grasp of his darts at the conclusion of the test from that of the beginning. The same observation was also made by reactors 1 and 3, the difference they represented being that of firmness or tenacity of hold. This aspect of throwing possibly results from a reduction of activity to a near automatism on the part of the reactor as the test progresses through the daily test interval.

Reactor 6. Age eighteen years, four months.

Reactor 6 smoked for the first time at the age of twelve. The cigar he used at that time made him sick. He has used tobacco regularly for the past three years. He smokes cigarettes mostly and a pipe to some extent, and inhales the smoke of both into his lungs. A package of cigarettes—20 cigarettes—lasts him about three days. The reactor evidently has smoking "sprees." On one occasion last spring, he alleges, he smoked three packages of cigarettes, one cigarette after another. His motive in smoking, in his own words, is " to keep him company."

The reactor is averse to having any smoking privilege restricted, but is of the opinion that the use of tobacco might well be prohibited during the period of physical immaturity.

Reactor 6 threw with varying rates of speed and of force throughout the entire tests. Without apparent reason he would throw with great force and follow the same throw with one of much less intensity. This characteristic, no doubt, has the effect of reducing the import and value of the test findings. The lack of constancy, together with his varying deliberateness, seemed to be temperamental. He states that under stress or excitement he has an emotional muscular trembling. He detailed a recent incident where, in selling tickets at a football game, he felt his rights had been infringed upon by another so employed, and a verbal altercation ensued. After the matter had been adjusted he experienced this muscular trembling for some moments. On October 26 he demanded a reason for biting his finger nails, stating that he had gone to the extent of putting aloes upon his fingers to overcome this habit, but continues it undiminished. On examination they were discovered to be bitten down close to the flesh. Though the flesh had not been penetrated, it had been somewhat roughened thereby. He finds it unpleasant to turn around quickly for even a small number of times and finds it impossible to ride on a "merry-go-round" on account of the dizziness and nausea that ensues. While engaging in high-school

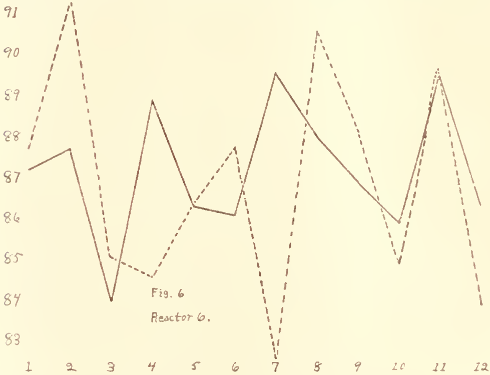

FIG. 6

athletics he was, on one occasion, struck on the head by a vaulting bar and received a severe skull injury. From this he fancies he still feels ill effects when very warm. He had a tendency in the laboratory to step as though he were afraid he would disturb some one, and reacted in the examiner's presence as though he were cultivating an air of composure.

A résumé of the general conditions of health, sleep and exercise for each working day of each reactor is given in tables 4 to 9.

The hours of going to bed and the duration of sleep for the preceding night are, of course, estimations, for the reliability of which we depended on the reactor's report. But since these reports were obtained each working day, for the preceding night, it may be reasonably assumed that they are approximations to the facts. These data are presented in order that any reader who may question whether certain variations were not due to physiological or other general conditions of the individual may satisfy himself on that point. The author's conclusion is that the variations cannot be so simply explained. In the first line of tables 4 to 9, D indicates preceding day, N indicates preceding night, and M indicates morning of the same day.

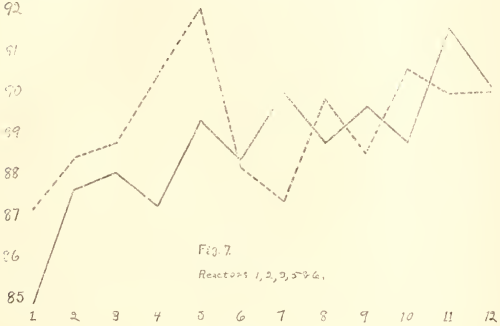

FIG. 7

TABLE 4

Résumé of psychobiological conditions

Reactor 1

	OCTOBER										NOVEMBER										DECEMBER	
	13	14	15	16	20	21	23	27	28	29	3	4	5	6	10	12	13	17	18	19	1	2
Smoked last	Smoked for test only																					
Cigar																						
Cigarette																						
Pipe																						
Went to bed	12	12	12	1	11	11	1	12	2	12	2	12	12	12	12	11	1	11	11	1	12	1
Hours of sleep	7	8½	7½	8	8	8	6	7	7	7	5½	8	7	8	7¾	8½	7	8½	8	7½	8½	8
Slept well	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Slept badly																						x
Today's exercise:																						
Walked 7 blocks	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x
Tennis one-half hour							x															
Ran 3 blocks													x									
Hour before test:																						
Walked 7 blocks	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x	x		x	x
Tennis one-half hour							x															
In class														x						x		
Reading at university													x									

Estimate of bodily feelings:																						
As usual	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x
Better than usual							x			x												
Indisposed																						
Alert as usual	x	x	x	x	x	x		x	x		x	x	x	x	x	x		x	x	x	x	x
Less alert																	x					
More alert							x			x												
Present worries:																						
Family matters																	x					x
Money matters								x														
Health																						
Studies																						
Social relations	Generally satisfactory																					

TABLE 5

Résumé of psychobiological conditions

Reactor 2

	OCTOBER								NOVEMBER														DECEMBER
	15	18	19	22	25	26	28	29	1	4	5	9	11	12	15	16	18	19	22	23	29	30	2
Smoked last	Smoked for tests only																						
Cigar																							
Cigarette																							
Pipe																							
Went to bed	12	11	11	11	12	11	1	1	1	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Hours of sleep	7	7½	7	8	7½	8	6½	6	6½	7½	7	7	7½	7½	7	7½	7	7	7½	7	7	7½	7
Slept well	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Slept badly			x																				
Today's exercises:																							
Walked to laboratory									x	x	x	x	x	x			x	x	x	x	x	x	x
Nothing in especial	x	x	x	x	x	x	x	x							x	x							
Hour before test:																							
In class	x			x			x	x		x	x		x	x			x	x					x
Reading in library		x	x		x	x			x			x				x			x	x	x	x	
Came from home (in car)															x								
Estimate of bodily feelings:																							
As usual	x	x				x	x	x		x		x	x		x	x	x	x	x	x	x	x	
Better than usual				x	x						x			x									x

Indisposed			x						x														
Alert as usual	x					x	x	x		x		x				x	x	x	x	x			
Less alert		x	x						x				x		x						x	x	
More alert				x	x						x			x									x
Calm			x	x	x	x	x	x	x	x	x	x	x	x						x	x		
Restless	x	x													x	x	x	x	x			x	x
Present worries:																							
Family matters																						x	
Money matters																							
Health									x														
Studies												x											
Social relations	Satisfactory, excepting with girl friends																						

TABLE 6

Résumé of psychobiological conditions

Reactor 3

	OCTOBER											NOVEMBER											
	13	15	16	20	21	22	23	27	28	20	30	3	4	5	6	10	11	12	13	17	18	19	20
Last smoked	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Cigar																							
Cigarette	x							x					x	x									x
Pipe		x	x	x	x	x	x		x	x	x	x			x	x	x	x	x	x	x	x	
Went to bed	11	12	12	12	12	11	1	12	12	11	12	3	11	11	12	10	12	12	12	12	12	12	11
Hours of sleep	8	7	9	7	7½	8	9	7½	7	8	9	4	8	8	8½	9	7½	7	8	8	8	10½	8
Slept well	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Slept badly																							
Today's exercise:																							
Ran up steps	x		x	x	x	x	x		x	x													
Walked to school								x				x	x	x	x	x	x	x	x	x	x	x	x
Hour before test:																							
Eating breakfast	x	x	x	x	x			x		x		x	x		x	x	x	x		x	x	x	x
Chemical laboratory																			x				
No report						x	x		x		x			x									
Estimate of bodily feelings:																							
As usual	x		x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x
Better than usual		x				x				x	x												

Indisposed																							
Alert as usual		x	x	x			x	x			x		x	x		x		x	x	x	x	x	x
Less alert												x											
More alert	x				x	x			x	x					x		x						
Calm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Restless																							
Present worries:																							
Family matters																							
Money matters																							
Health																							
Studies																							
Social relationships	Generally satisfactory																						

TABLE 7

Résumé of psychobiological conditions

Reactor 4

	OCTOBER								NOVEMBER									DECEMBER			
	12	13	18	19	20	25	26	27	1	3	15	16	17	22	23	29	30	1	6	7	8
Smoked last	M	M	M	M	M	D	M	D	M	N	M	D	M	N	M	D	M	N	M	N	M
Cigar																					
Cigarette	2	2	2	x	2		2		2		2		4		2		3		3		4
Pipe																					
Went to bed	10	11	8	9	12	8	11	11	9	11	10	10	11	9	11	10	11	11	10	11	12
Hours of sleep	9	8	10½	10	7	9	8	7½	10	8	9	8	7½	10	7½	9	8	8	9	8	7
Slept well		x	x		x	x	x	x	x	x	x	x	x	x	x		x	x		x	x
Slept badly	x			x												x			x		
Today's exercise:																					
To school on car	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hour before test:																					
In class	x		x	x		x	x		x		x	x		x	x	x	x		x	x	
Studying in library		x			x			x		x			x					x			x
Estimate of bodily feelings:																					
As usual	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Better than usual																					
Indisposed																			x*		
Alert as usual	x	x		x	x	x	x		x	x	x		x	x	x	x	x	x		x	x
Less alert			x									x							x		

More alert								x													
Calm	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Restless													x								
Present worries:																					
Family matters																					
Money matters																					
Health																					
Studies	x														x						x
Social relationships	Generally satisfactory																				

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* Feels dejected.

TABLE 8

Résumé of psychobiological conditions

Reactor 5

	OCTOBER													NOVEMBER									
	13	14	15	18	19	20	21	22	25	26	27	28	29	1	3	4	5	10	12	15	16	17	18
Smoked last						D		D	D	D		D				D	M		M	D	D	D	M
Cigar						x		x	x	x		x				x				x		x	
Cigarette																	x		x		x		x
Pipe																							
Went to bed	10	11	10	9.30	10	11	12	11	11	12	11	11	11	11	10	12	11	12	11	11	11	12	11
Hours of sleep	8½	8	8	10	9	7½	6½	8½	8	7	7½	7	8	8	8	6½	8½	6	7½	8½	7½	6	7½
Slept well	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Slept badly										x													
Today's exercise:																							
Walked 1½ miles	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Nothing in especial										x													
Hour before test:																							
Walked 8 blocks			x	x			x	x			x	x	x	x		x	x						
Ate lunch									x	x													
In class or laboratory	x	x				x																	
Reading in library					x									x	x	x			x	x		x	x
Playing cards				x				x	x														
Estimate of bodily feelings																							
As usual	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x					
Better than usual																							

Indisposed								x*											x*	x*	x*	x*	x*
Alert as usual	x	x		x	x	x		x		x	x	x	x	x	x	x	x	x	x		x	x	
Less alert			x				x		x											x			x
More alert																							
Calm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Restless																							
Present worries:																							
Family matters																							
Money matters																x		x	x	x	x	x	x
Health																							
Studies			x										x	x									
Social relationships	Satisfactory, excepting with girl friends, October 14 to November 1																						

* October 22, headache. November 12, 15, 16, 17, 18, nasal cold.

TABLE 0

Résumé of psychobiological conditions

Reactor 6

	OCTOBER										NOVEMBER												DECEMBER
	12	13	14	16	18	19	20	21	26	27	1	3	4	6	10	16	17	18	20	22	23	30	1
Smoked last	D	D	N	D	D	N	N	N		D	D	M	D	D	D	D			N			N	
Cigar										½													
Cigarette	4	4	5	6	5						3	x	3		x	x			2				
Pipe					4	x	x	x						x								x	
Went to bed	11	11	12	10	11	11	11	12	11	11	11	12	10	11	11	11	11	11	11	11	1	11	11
Hours of sleep	8	8½	7¼	8	7¾	7¾	7½	7	8	8	8	7	8	8	8	8	8	7½	8	8	6	8	8
Slept well	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Slept badly																							
Today's exercise:																							
Walked 20 blocks	x	x	x	x	x	x	x	x						x	x				x	x			
Nothing in especial									x	x	x	x	x			x	x	x			x	x	x
Hour before test:																							
Came from home	x							x	x					x									
In class or laboratory		x			x	x	x			x		x			x		x						
Reading in library			x								x		x			x		x		x	x	x	x
Surveying				x															x				

Estimate of bodily feelings:																							
As usual	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Better than usual																							
Indisposed		x*																					
Alert as usual				x	x	x	x	x	x	x		x	x	x	x			x					
Less alert	x	x	x								x					x	x		x	x	x	x	x
More alert																							
Calm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Restless																							
Present worries:																							
Family matters																							
Money matters																							
Health																							
Studies	x									x							x	x		x			x
Social relationships	Generally satisfactory																						

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* Slight headache.

TABLE 10

Target scores, consecutive sets

Reactor 1

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 1 (practice)													
October 6	78	84	86	75	73	81	83	79	76	82	75	80	79.33
October 7	82	100	86	82	88	86	80	80	80	88	89	89	85.00
October 8	82	94	88	91	93	97	98	96	86	99	89	81	91.16
October 9	74	75	90	95	75	76	97	93	90	103	100	89	88.08
October 13	86	84	84	104	76	92	92	91	90	83	88	108	89.75
October 14	83	73	86	90	94	88	90	87	76	87	89	74	84.75
October 15	81	76	74	82	69	91	90	83	72	94	106	98	84.66
Average	80.9	83.7	84.6	88.4	81.1	87.4	90.0	87.0	81.4	90.9	90.9	88.4	
Schedule 2													
October 20	92	106	107	104	97	101	97	89	92	84	75		94.90
October 23	102	83	72	82	79	92	77	83	99	100	85		86.72
October 28	78	66	84	56	92	80	69	77	74	84			76.00
November 3	84	88	93	87	99	84	88	94	103	76	91	78	88.75
November 5	82	63	95	94	83	89	89	100	100	87	104	103	90.75
November 10	81	98	98	94	91	93	95	88	75	76	63	99	87.58
November 13	90	95	103	81	84	77	63	78	80	83	61	66	80.08
November 18	78	77	80	73	101	96	92	80	79	80	91	62	82.41
November 20	87	79	70	86	82	81	91	78	91	79	94	91	84.08
December 2	86	70	80	90	71	63	82	74	102	105	96		83.54
Average	86.0	82.5	88.2	84.7	87.9	85.6	84.3	84.1	89.5	85.4	84.4	83.1	*85.50*

Schedule 1

October 16	94	87	93	100	82	88	87	66	86	87	88		87.09
October 21	86	87	89	92	85	84	71	78	77	90	67	88	82.83
October 27	104	95	74	81	89	104	81	79	69	76	91	71	84.50
October 29	105	79	83	96	94	80	78	79	72	65	100	91	85.16
November 4	83	73	90	93	83	90	96	83	85	84	66	87	84.41
November 6	80	82	70	67	88	85	95	92	99	106	109	87	88.33
November 12	81	76	90	85	85	75	89	86	87	88	85	85	84.33
November 17	95	86	80	89	88	70	76	81	65	78	96	91	81.25
November 19	89	74	83	101	101	71	81	93	89	90	94	106	89.33
December 1	68	70	65	91	93	82	75	81	79	93	81	83	80.08
Average	88.5	80.9	81.7	89.5	88.8	82.9	82.9	81.8	80.8	85.7	87.7	87.6	*84.9*

TABLE 11

Target scores, consecutive sets

Reactor 2

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 1 (practice)													
October 8	90	103	98	92	99	94	95	90	92	83	101	92	94.08
October 11	81	83	89	71	83	70	78	91	91	100	88	86	84.25
October 12	80	83	77	63	60	62	94	71	83	79	74	67	74.41
October 14	77	80	85	86	75	84	93	75	97	67	76	91	82.17
October 15	84	79	91	70	68	58	48	41	41	46	79	79	65.33
October 18	81	93	101	91	93	99	83	90	83	88	86	84	89.33
October 19	92	77	68	79	92	69	76	76	75	77	84	78	78.58
Average	83.6	85.4	87.0	78.9	81.4	76.6	81.0	76.3	80.3	77.1	84.0	82.4	
Schedule 2													
October 22	71	74	86	72	82	78	93	78	74	88			79.60
October 26	77	68	68	51	72	74	64	82	78	93	88	90	75.42
October 29	88	85	89	93	88	96	109	96	101	96	99	101	95.08
November 4	70	83	77	75	84	87	95	82	91	88	89	89	84.17
November 9	80	90	91	95	93	97	96	95	100	81	93	102	92.75
November 12	73	94	88	97	94	94	92	89	99	91	96	92	91.58
November 16	84	89	92	100	96	95	104	96	95	92	100	98	95.08
November 19	84	87	89	91	103	92	97	89	96	99	102	106	94.58
November 23	87	84	81	84	87	85	96	91	99	98	96	103	90.92
November 30	86	94	95	91	90	96	91	99	96	97	96	106	94.75
Average	80.0	84.8	85.6	84.9	88.9	89.4	93.7	89.7	92.9	92.3	93.9	96.7	*89.4*

Schedule 1

October 21	85	82	86	82	59	59	83	72	83	85			77.60
October 25	83	62	94	86	71	67	65	78	83	87	76	83	77.92
October 28	89	96	95	102	96	91	96	107	91	96	94	92	95.42
November 1	87	86	90	93	88	84	92	88	99	85	85	90	88.92
November 5	72	93	93	97	87	88	95	100	98	95	90	96	92.00
November 11	84	90	96	90	94	98	94	106	100	96	95	96	94.92
November 15	88	89	101	91	101	102	97	96	106	97	101	89	96.50
November 18	90	84	86	82	85	91	93	98	90	95	94	99	90.58
November 22	72	82	92	89	99	99	98	92	91	98	71	106	90.75
November 29	91	89	91	98	96	100	92	100	89	102	95	92	94.58
Average	84.1	85.3	92.4	91.0	87.6	87.9	90.5	93.7	93.0	93.6	87.9	92.1	*89.9*

TABLE 12

Target scores, consecutive sets

Reactor 3

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 1 (practice)													
October 7	80	72	94	91	90	90	78	84	95	90	92	84	86.66
October 8	84	95	93	98	97	96	85	87	93	90			91.80
October 9	74	78	89	90	102	86	91	83	89	77	88		86.09
October 13	81	97	86	91	89	93	89	88	77	84	105	94	89.51
October 15	85	97	91	88	93	89	77	88	66	92	100	97	88.58
October 16	70	85	91	92	73	82	86	85	102	102	97	81	87.16
Average	79.0	87.3	90.6	91.6	90.6	89.3	84.3	85.8	87.0	87.5	96.4	89.0	
Schedule 1													
October 20	93	97	95	103	101	91	88	104	89	101	98	97	96.41
October 22	79	101	94	101	101	79	99	87	90	97	84	78	90.83
October 27	99	100	106	95	102	103	88	94	88	100	104		98.09
October 29	89	99	94	96	102	93	80	84	93	99	97	98	93.66
November 3	88	96	102	94	101	104	104	107	95	96	103	103	99.41
November 5	96	101	100	104	94	98	94	104	99	91	91	98	97.50
November 10	86	95	95	100	84	97	94	96	88	109	94	96	94.50
November 12	86	91	99	105	100	101	90	96	92	109	91	102	96.66
November 17	94	90	105	104	92	98	97	100	102	96	112	105	99.50
November 19	91	100	87	92	99	105	99	93	98	112	97	89	99.83
Average	90.1	97.0	97.7	99.4	97.6	96.9	93.3	96.5	93.4	101.0	97.1	96.2	*96.37*

Schedule 2

October 21	77	86	94	83	84	81	96	98	96	91	94		89.09
October 23	89	75	96	94	100	97	96	98	95	98	99	103	95.00
October 28	80	105	96	99	103	99	98	97	80	86	96		94.45
October 30	93	92	93	93	105	97	99	108	99	99	100	103	98.41
November 4	91	97	93	100	88	98	93	93	91	105	93	98	95.00
November 6	100	99	100	103	104	95	100	98	95	99	90	91	97.83
November 11	90	101	90	97	100	104	96	92	97	88	100		95.91
November 13	96	93	94	88	102	99	91	96	97	98	100	96	95.83
November 18	89	93	98	85	96	96	104	108	96	98	89	98	95.83
November 20	97	93	97	85	87	101	89	89	89	98	96	84	92.08
Average	90.2	93.4	95.1	92.7	96.9	96.7	96.2	97.7	93.5	96.0	95.7	96.1	*94.92*

TABLE 13

Target scores, consecutive sets

Reactor 4

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 4 (practice)													
October 11	72	93	83	79	87	89	87	89	87	89			85.50
October 12	43	74	91	82	87	90	80	84	94	80	81	89	81.25
October 13	73	88	84	87	91	91	88	80	84	82	90	87	83.41
October 18	68	74	87	67	73	75	70	79	74	84			75.10
October 19	84	89	90	83	75	83	79	85	84	86	82	80	83.33
Average	68.0	83.6	87.0	79.6	82.6	85.6	80.8	83.4	84.6	84.2	84.3	85.3	
Schedule 5													
October 25	94	97	86	92	100	99	87	73	77	82	92		89.00
October 27	73	76	93	93	85	86	77	99	92	80	83	90	85.58
November 3	93	87	86	87	79	90	88	99	96	97	90	88	90.00
November 16	85	93	88	85	87	80	87	96	91	87	82		87.36
November 22	95	88	82	95	83	88	90	106	86	89	79	100	90.08
November 29	83	90	102	92	95	88	76	87	100	96	87	85	90.08
December 1	91	82	88	87	99	97	102	95	96	95	105	108	95.41
December 8	91	93	95	99	94	101	96	89	90	91	103	96	94.83
Average	88.1	88.3	90.0	91.3	90.2	91.1	87.9	93.0	91.0	89.6	90.1	94.5	*90.26*

Schedule 4

October 20	90	98	88	82	94	98	96	95	94	94	93	101	93.58
October 26	83	99	92	98	102	94	104	80	100	94	91	104	95.08
November 1	88	79	96	93	89	90	89	92	91	96	98		91.00
November 15	87	86	91	87	87	96	85	81	92	87	75	96	87.50
November 17	91	82	98	99	96	91	85	82	92	101	86	88	90.91
November 23	85	94	95	87	89	87	96	93	92	91	96	91	91.33
November 30	93	92	107	91	89	83	86	97	83	83	90	101	91.25
December 6	105	87	93	94	95	99	89	83	84	100	95	90	92.83
Average	90.3	89.6	95.0	91.5	92.6	92.3	91.3	87.9	91.0	93.3	90.5	95.8	*91.70*

TABLE 14

Target scores, consecutive sets

Reactor 5

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 1 (practice)													
October 7	65	96	88	92	83	90	94	85	86	105	83	90	87.66
October 8	83	86	85	96	91	88	89	91	91	80	84	86	87.50
October 11	84	88	77	76	89	95	77	81	87	77	87	91	84.08
October 12	85	79	80	98	93	74	83	80	72	97	85	80	83.88
October 13	86	101	84	89	87	88	85	81	76	84	93	90	84.00
October 14	86	81	91	86	83	92	87	91	82	90	77	86	86.00
October 15	82	94	90	91	84	78	82	89	87	95	96	77	87.06
Average	81.6	89.3	85.0	89.7	87.1	86.4	85.3	85.4	83.0	89.7	86.4	85.7	
Schedule 2													
October 19	74	64	88	91	91	79	89	79	69	67	71	83	78.75
October 21	64	77	77	73	95	82	82	70	80	74	78	91	78.58
October 25	86	99	91	72	79	78	82	87	78	87	79	79	83.08
October 27	76	96	85	88	87	86	87	84	85	84	88	90	86.33
October 29	85	80	89	88	89	87	97	84	90	92	91	92	88.66
November 3	84	84	87	83	84	92	87	83	100	92	95	95	88.85
November 5	89	90	97	92	84	79	84	92	86	86	84	90	87.75
November 12	89	87	90	96	85	86	97	86	86	91	94	86	89.41
November 16	84	81	81	86	85	84	77	86	95	92	83	92	85.50
November 18	82	89	93	86	94	92	85	96	90	82	82	90	88.44
Average	81.3	84.7	87.8	85.5	87.3	84.5	86.7	84.7	85.9	84.7	84.5	88.8	*85.53*

Schedule 1

October 18	72	78	88	104	88	84	89	84	86	79	91	83	85.50
October 20	70	90	84	87	95	85	85	78	80	89	91	85	84.91
October 22	88	94	86	77	86	94	82	97	86	83	86	91	87.50
October 26	81	82	81	83	89	68	87	80	83	80	79	87	81.66
October 28	88	88	82	81	93	87	93	82	86	89	84	92	87.08
November 1	92	88	88	88	91	87	87	90	88	93	90	94	89.66
November 4	82	88	86	94	92	89	84	87	93	97	93	91	89.66
November 10	99	86	88	95	78	93	96	100	87	97	81	101	91.75
November 15	105	92	100	92	99	86	85	91	101	86	88	94	92.41
November 17	81	93	91	79	89	94	90	83	88	87	97	89	88.44
Average	85.8	87.9	87.4	88.0	90.0	86.7	87.8	87.2	87.8	88.0	88.0	90.7	*87.94*

TABLE 15

Target scores, consecutive sets

Reactor 6

DATE	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Schedule 1 (practice)													
October 6	77	90	67	89	82	82	67	93	81	74	86	82	80.83
October 7	75	88	89	95	92	89	89	86	84	92	76	94	87.41
October 9	71	95	84	86	90	76	86	89	81	94	88	97	86.41
October 11	84	84	85	85	70	83	94	97	86	77	95	94	86.17
October 12	79	71	76	91	88	84	82	76	83	88	82	87	82.25
October 13	77	87	74	90	95	95	87	99	87	85	80	73	85.75
October 14	88	80	89	85	83	83	86	75	88	78	87	77	83.25
Average	78.7	85.0	80.6	88.7	85.7	84.6	84.7	87.9	84.3	84.0	84.9	86.3	
Schedule 2													
October 18	79	96	90	97	86	83	94	82	72	91	93	77	86.66
October 20	80	91	83	84	84	88	83	85	83	92	97	93	86.92
October 26	93	74	73	90	84	80	89	78	68	73	87	81	80.82
November 1	102	100	76	90	75	81	87	86	94	84	84	88	87.25
November 4	81	83	82	79	78	89	83	89	92	90	84	90	85.00
November 10	77	85	88	80	82	89	103	93	90	78	85	89	86.58
November 17	87	80	84	88	89	92	82	88	87	82	78	68	83.75
November 20	89	88	85	86	97	77	87	90	88	84	103	82	88.00
November 23	89	85	90	95	97	93	98	87	98	94	90	97	92.75
December 1	96	96	90	101	92	90	91	103	98	92	96	99	95.33
Average	87.3	87.8	84.1	89.0	86.4	86.2	89.7	88.1	87.0	86.0	89.6	86.4	*87.30*

Schedule 1

October 16	90	93	81	73	91	87	87	87	79	72	83	68	82.58
October 19	84	83	96	90	81	86	78	84	83	87	93	82	85.42
October 21	95	81	88	76	93	89	80	96	92	82	98	88	88.17
October 27	74	89	82	94	91	94	74	87	90	85	86	84	85.83
November 3	82	96	82	92	92	91	95	92	94	82	105	83	90.50
November 6	99	98	84	87	88	87	78	95	94	95	88	96	90.75
November 16	92	90	87	97	78	88	82	98	81	80	85	83	86.83
November 18	79	89	72	71	81	84	76	96	83	87	79	76	79.42
November 22	90	97	82	84	80	85	77	76	94	85	82	94	85.50
November 30	93	98	98	83	90	88	100	96	92	95	98	86	93.08
Average	87.8	91.4	85.2	84.7	86.5	87.9	82.7	90.7	88.2	85.0	89.7	84.0	*86.98*

4. Daily and average scores

Tables 10 to 15 give the scores for each set of each reactor in the practice series and in the twenty-days' series of the two test schedules. Averages are given for each day's work at the end of the lines for the days; averages for all of the first sets, second sets, etc., for the ten days of each schedule, at the bottoms of the columns; and the general average for each of the schedules is given in italics. The average deviation (mean variation) and probable error of these general averages are given in table 16. The graphs in figures 1 to 7 are drawn from the set-averages of these tables. The scores for each set were obtained, as described above, by counting each dart in the bull's eye (circle 6) as 6 points, and darts in the other rings from the center as 5, 4, 3, 2 and 1, respectively. Darts falling outside the limits of the largest circle (circle 1) were counted as zero.

TABLE 16

Mean variations and probable errors of the average scores

	REACTOR					
	1	2	3	4	5	6
Smoking						
Mean variation	9.27	7.66	4.74	9.74	5.45	5.86
Probable error	7.84	6.48	3.77	8.17	4.59	4.95
Non-smoking						
Mean variation	7.74	7.98	5.51	5.97	4.90	6.06
Probable error	6.60	6.74	4.66	5.05	4.14	5.12

The average scores for the "smoking" days and the "non-smoking" days of reactors 1, 2, 3, 5 and 6 show little difference. Reactors 1 and 2, who were non-smokers during the months of the tests, except for the prescribed smoking of schedule 2, have scores 0.6 per cent better in the smoking and 0.5 per cent better in the non-smoking schedules, respectively. This is a remarkably close approximation of the two scores in each case. Of the 3 smokers, reactors 3 and 5 have non-smoking scores 1.45 per cent and 2.41 per cent better than their smoking scores, but reactor

6 has a smoking score 0.32 per cent better than his non-smoking score. The difference for this reactor is so small that it is entirely negligible. It will be noted from the "personal notes" (p. 377) that reactors 1 and 2, who smoked cigarettes in the test, did not inhale the smoke. This is, of course, important in connection with the negative results for their tests. But reactor, 6 who shows negative results, did inhale.

The results so far then, indicate that the *immediate* effects of moderate smoking (1 cigar or 2 cigarettes) vary from negligibility to slight disturbance of accuracy by the smoking: results quite in accordance with Carver's findings.

Reactor 4, who worked on a different schedule, has a higher average score (1.48 per cent) on his smoking days than on his non-smoking days. But in this case there is no immediate effect of smoking, since the reactor did not smoke in any of the tests; but rather an effect of abstinence, during the preceding part of the day, from his accustomed smoking. If we could assume that reactors 3 and 5, on the non-smoking days, were deleteriously affected by abstinence from the customary smoking during the non-smoking days, and that on the smoking days, the effects of the smoking during the tests were mixed, the deteriorative (for these reactors) immediate effects being complicated by the partial removal of the effects of abstinence, the score-difference for these reactors would become of more importance. But in any case, the difference in the scores of these two reactors seems to indicate a slight detrimental immediate effect of smoking, for although the differences are less than 2 per cent, and less than the probable error, they are based on a sufficiently large number of cases (approximately 3000 darts in each of the two schedules).

5. *The actual distribution of darts*

The method of scoring by any definite values to the several rings of the target, is, of course, arbitrary, and it might be suspected that other methods of scoring might give different results. For this reason, the comparisons are made in table 17 on the basis of the actual percentages of the total number of darts in the total smoking and non-smoking sets (3000 darts in each, in most cases) included within the several rings and the bull's eye.

It will be noted that in table 17 the percentages for each circle include the percentages for the circles within that circle. For example: the percentage for circle 4 includes darts in circles 5 and 6, as those darts are all within 4.

TABLE 17

Percentages of darts within the several rings of the target

REACTOR	SCHEDULE	RINGS					
		6	5	4	3	2	1
1	1	0.8	19.7	52.8	78.4	91.4	96.3
	2	0.9	20.1	53.7	79.2	91.1	96.7
2	1	0.5	22.0	59.8	84.2	94.9	98.2
	2	1.3	22.2	59.8	83.4	93.4	97.2
3	1	1.4	27.2	68.0	90.8	98.1	99.6
	2	1.3	24.3	66.7	90.1	97.6	99.5
4	4	1.0	22.3	62.2	86.4	95.7	98.8
	5	1.3	22.3	59.1	84.3	95.1	98.5
5	1	1.0	20.5	56.6	81.1	94.0	97.4
	2	1.0	18.8	53.2	79.0	92.2	97.3
6	1	1.2	20.1	55.4	80.1	93.2	97.7
	2	0.9	19.6	56.0	81.6	93.1	97.9

In table 17 it is seen that reactor 1 shows but slight difference between the number of darts within any ring for smoking and non-smoking schedules. No simple method of scoring would make the total scores for the two schedules differ to an important extent. Reactor 2 shows slightly more difference between the two schedules; a slightly higher number for the bull's eye (ring 6), the same number within ring 4, and fewer in rings 3, 2, and 1; in the smoking as compared with the non-smoking schedule. In other words, a tendency to scatter, in this smoking schedule, in a certain way, so that a few more of the highly successful (bull's eye) throws, and a few more "wild" throws, are made, than in the non-smoking schedules. Nevertheless, the total tendency to scatter is less in the smoking schedule for this reactor than in the non-smoking, as shown by the measures of variation (table 16). The distribution curve for the two schedules is of a different type. It is interesting to note that of the total throws of all reactors which completely missed the target, 240 were on "smoking" days, 208 on "non-smoking."

Reactors 3 and 5, while showing approximately the same percentages of hits in the bull's eye, in both schedules, show a higher percentage in the second, third, fourth and fifth rings in the smoking schedule than in the non-smoking: a showing entirely in accord with the results of the scores in tables 10 and 14. Reactor 6, whose "smoking" score in table 15 is very slightly better (0.32 per cent) than his non-smoking score, has a slightly higher number of darts in the bull's eye and in ring 5 in the non-smoking schedule, but has a higher number within rings 4 and 3 in the smoking. In other words, the scatter is less for the smoking score.

Reactor 4, who worked on schedules different from those of the other reactors, with a somewhat better score on the "smoked as usual" days (schedule 4) than on the abstinence days, shows distributions consistent with the difference, for although more bull's eyes were made on abstinence days, more darts were placed within the fourth, third and second rings and as many within the fifth and first on the smoking days, the darts averaging nearer the center on the smoking days.

The method of scoring, therefore, appears to be adequate, and the measure of variation also may be taken from the scores. The average deviation of the total scores for each reactor are given in table 16, together with the probable errors of the scores. In every case but one, the variation is less for the smoking days: in the case of reactor 2, the variation is slightly higher for the smoking days. In other words, the distribution is more uniform —less scattering—after smoking. This effect of tobacco is apparently independent of the effect on the average score.

6. *Variations in efficiency throughout the hour*

The progress of the throwing through the working hour shows some interesting peculiarities. On all except a few days, 12 sets of 25 darts each were thrown in schedules 1 and 2. The scores for each set on each day are given in tables 10 to 15, and the set-averages (that is, the averages for the first set on the ten days of each schedule, the average of the second set on the ten days, and so on) are given at the bottom of the column for each schedule. These set-averages show significant variations.

The graphs of figures 1 to 6 show the values of the set-averages for each reactor. In each figure, the numbers at the left are score values, and the numbers at the bottom indicate the successive sets of 25 darts each thrown in each hour. The dotted line in figures 1, 2, 3, 5 and 6 represents the course of the set averages for the non-smoking days; the solid line in these figures represents the course for the smoking days. Each of the 12 ordinates of each graph represents, therefore, the average of the scores of the corresponding set on ten days: representing, therefore, a total of 250 darts each.

In figure 4, the dotted line represents the "deprivation of smoking" schedule (schedule 5), and the broken line the "smoking as usual" schedule (schedule 4).

In general, the fluctuation of the smoking averages are less violent than those of the non-smoking. In other words, the smoking averages show a more consistent course from the first to the twelfth. This is especially noticeable in reactors 1, 2, 3 and 6, not significantly with 4 and 5. It is noticeable that in every case there is a slump in the non-smoking curve towards the middle of the hour, with recovery towards the end. The smoking curve of reactors 4 and 5 show similar slumps and recoveries, but the smoking curve of reactors 2 and 6 show no such slump, and the slump for reactors 1 and 3 occurs at the end of the smoking curves. It is interesting to note that each of these pairs of reactors consists of a cigarette smoker and a cigar smoker, and also that there is here a distinct effect of the smoking on reactors 1 and 2, although the average daily scores of these reactors are not affected significantly, as shown in tables 10 and 11.

The general tendencies discoverable in the graphs of the several subjects are clearly apparent in the graph of the combined average of reactors 1, 2, 3, 5 and 6 (fig. 7). This graph shows a higher average score for schedule 1 (non-smoking) over schedule 2 for the early part of the hours: then a slump followed by recovery. The greater consistency of the "smoking" work is clearly apparent. While the group averages of the reactors' scores would not by itself be admissible evidence, it is significant in connection with the individual scores and does actually exhibit a general tendency, in spite of the individual variations.

Apparently, we have here a distinct effect of smoking. The course of efficiency throughout the hour is the same for all reactors, when they have not recently smoked: there is in all cases a tendency to slump after the first spurt, and a subsequent recovery. But immediately after smoking, the course of the efficiency is different for 4 reactors. One reactor fails to show this difference, and the remaining reactor (reactor 4) was not tested immediately after smoking. The fact that the alteration in the course of the efficiency for 2 reactors is somewhat different from that for the other 2 may reasonably be considered a matter of individual difference in susceptibility, or difference in the temporal course of the tobacco effects. It is possible that the 2 reactors who show no terminal slump in the smoking curve would have shown it a little later: that is to say, that the effects of smoking in all 4 cases is to *postpone* the slump. The one reactor (reactor 5) who shows no disturbance of the course of efficiency by smoking, is one who shows no other significant effect of smoking.

7. *Vertical and horizontal distributions*

As has been described above, the target was divided, by vertical and horizontal lines through the center of the bull's eye, into four quadrants. Records were kept of the number of darts in each set falling in each quadrant, and analyses were made of these records in order to find possible significant variations in the vertical and lateral distributions of the darts. These analyses yielded nothing of consequence. Table 18 presents the general averages of the smoking and non-smoking sets of each reactor, showing the average number of darts falling in upper and lower halves of the target, and in the right and left halves. It will be noticed that the vertical distribution for each reactor is approximately the same for each of his two schedules, and that although there is perhaps a tendency on the part on Reactors 1, 3, 5 and 6 to throw more to the left after smoking, as compared with the non-smoking schedule, the evidence for this tendency is unimportant. The analysis of the quadrants in respect to daily differences and differences in the progressive sets of the hour was likewise productive of negative results. It was noted, however, that there are characteristic individual differences in distribution, some reactors having a distribution wider vertically than horizontally, others the reverse, and others showing a diagonal distribution. It was also noted that there were two tendencies shown after making wild throws, some reactors tending to throw the next dart into the opposite quadrant, as in over compensating for the error, others not showing this tendency. This factor as a detail in the correction of error might well be studied during the early learning period, in respect to its effect on improvement.

TABLE 18

Average vertical and horizontal distribution of darts

REACTOR	SCHEDULE	UPPER	LOWER	RIGHT	LEFT
1	1	11.00	14.00	12.36	12.64
	2	10.47	14.53	12.20	12.80
2	1	11.76	13.24	11.52	13.48
	2	11.51	13.49	11.90	13.10
3	1	12.18	12.82	13.92	11.08
	2	12.12	12.88	13.74	11.26
4	4	10.81	14.19	13.70	11.30
	5	10.08	14.92	13.17	11.83
5	1	11.40	13.60	11.80	13.20
	2	12.19	12.81	11.00	14.00
6	1	13.07	11.93	12.43	12.57
	2	12.55	12.45	12.05	12.95

8. Speed of throwing

The time taken by the subject in throwing each set of 25 darts was taken with a stop-watch throughout the whole series of tests. The average throwing times for the 6 reactors are given in table 19, in which it will be noticed that the time is slightly shorter for the smoking schedule (schedule 2) of reactors 2, 5, and 6, and slightly longer for reactors 1 and 2, than for the non-smoking schedule. The difference seems negligible, especially in view of the values of the coefficient of correlation between speed and accuracy, r, in the same table.

TABLE 19

Average time of throwing a set (25) of darts, and coefficients of correlation between speed and accuracy of throwing

	REACTORS					
	1	2	3	4	5	6
Non-smoking						
Average deviation	44.85	41.42	48.18	60.40	35.30	51.36
r	0.58	−0.38	−0.22	−0.24	−0.30	−0.006
Smoking						
Average deviation	45.25	41.29	47.37	61.97	34.70	50.02
r	−0.12	−0.61	−0.33	−0.11	−0.17	0.04

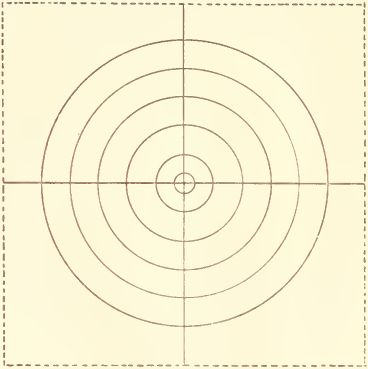

FIG. 8. PATTERN FOR TARGET ONE-TWELFTH ACTUAL DIAMETER

The targets were blue-printed from this pattern and hence had white bull's eye, rings and cross-lines, on a dark blue ground. The dotted lines indicate the edges of the target.

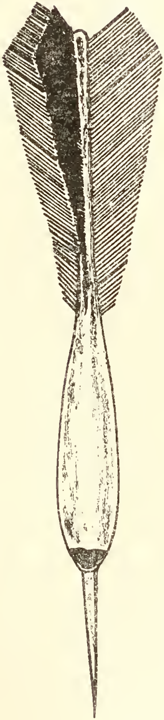

FIG. 9. DART ACTUAL SIZE

The body and tail are wood, the point of steel; the tail is feathered. Length of dart (including point, body and tail, exclusive of feathers) 6 inches. Weight approximately 12.8 grams.

THE EFFECTS OF CIGAR AND CIGARETTE SMOKING ON CERTAIN PSYCHOLOGICAL AND PHYSIOLOGICAL FUNCTIONS[1]

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II. BLOOD PRESSURE AND HEART RATE

Attempts have been made by several investigators to measure the effects of tobacco smoking upon systolic and diastolic pressure. In such investigations, the number of measurements are usually too small to give reliable results, in some cases a single determination of systolic pressure being made before smoking, and a single determination after smoking. Consideration of the various causes which operate in establishing and varying blood pressure indicates that such investigations are unreliable, and that although the conclusions might in some cases be true, the evidence does not warrant them.

As has been already pointed out by Carver,[2] the method of investigation of blood pressure changes developed by Dunlap and Bagby, and subsequently used in the physiological branch of the Air Medical Service, is quite applicable to problems such as those of tobacco smoking. This method consists in making a reading, with a clinical sphygmomanometer, every two or three minutes, over a prolonged interval. A well trained examiner may readily make sufficiently accurate readings of both systolic and diastolic pressure every two minutes, and in the intervening periods, may make counts of heart rate. In this procedure, a blood-pressure reading is commenced on the first, third, fifth and so on, minutes. The systolic and diastolic pressures are determined in from thirty to forty seconds, and the arm bandage is then immediately deflated, and remains deflated until the beginning of the next reading. In this way, no deleterious effect on the circulatory system is produced, as would be the case if the bandage were kept continuously inflated. The bandage is easily kept in place throughout the test, even for several hours, so that no time is lost in adjustment.

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[1] The first installment of this contribution appeared in the October, 1922, number of this Journal.

[2] Journal of Comparative Psychology, vol. II, no. 4, pp. 279–302.

This method seems as close an approximation to the method commonly employed in recording the blood pressure of dogs and other animals, as can be made on the human reactor. In this way, the courses of the systolic and diastolic pressures are followed and both the general levels and fluctuations are observed. If only a few observations are made, it is not known whether the measurements obtained represent the general level, or fluctuations due to various causes—such fluctuations as are the rule rather than the exception—or unusual levels due to preceding conditions.

In the work here reported, the pressure determinations were made every three minutes, instead of every two, for reasons which will appear later. It is probable that for experimental work of this kind the three-minute system is quite adequate, although in cases where the patient is being subjected to adverse conditions, such as asphyxiation, and the purpose of the blood pressure readings is to protect him from syncope, the two-minute readings afford a greater measure of safety.

Six reactors were employed in these tests, all being students in the Johns Hopkins University.[3] All but one were men. Each reactor came to the laboratory, on the average of twice a week, such time or hours being arranged as would not conflict with the class schedules. Upon reaching the laboratory, the reactor was comfortably seated in a semi-reclining position in a regulation barber's chair (fig. 17). It was in this position that al blood pressure and heart rate readings were made. Twenty to twenty-five minutes of rest in the chair were allowed each subject before tests were begun. This was done to minimize such effects as might result from the exertion of coming to the laboratory, or of other recent activity. During the rest-period and thereafter until the conclusion of the test, the reactor did nothing except engage in commonplace conversation with the examiner. This was considered desirable in that the reading of books, articles, or other literature might vary the emotional tension, while the attempt to have the reactor "do nothing" during both rest-period and test-period gives no reliable control. By conversing, the examiner could control the reactor's conversation, and therefore, to some extent, his thoughts.

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[3] The daily records of sleep and activities of the reactors are not presented here. Such records are highly important, if they are not only accurate but comprehensive. The records presented in tables 1–19, part I, of this report, are merely outlines of what ought to be obtained, and without which work of this character can not be considered to be really complete. Satisfactory records of the daily life of reactors are, however, manifestly unattainable unless the reactors are kept under controlled living conditions and practically under continuous observation; and this is possible only with provision and expenditure which are beyond the reach of the experimenter under usual conditions.

At the expiration of the rest period, blood pressure and heart rate readings were taken every three minutes with the omission of the ninth and the twentieth times, in which a free association test was conducted. The details of this will be described later (part III). Approximately two hours elapsed from the time the reactor reached the laboratory until he left the chair.

All blood pressure readings were made from the left arm with the exception of reactor 10. The right arm was used in this instance because the index of systolic pressure in this reactor was more definite in the right arm. The method of taking blood pressure in these tests was the usual one, approximately as described in the manual published for the Taylor Instrument Company to accompany their instrument known as the "Tycos" sphygmomanometer. The auscultation method was employed, and readings were made according to the "silence to silence" criterion, the fifth phase or "disappearance of all sound" being regarded as the diastolic index.

While this method is not recommended for clinical purposes, it is obviously the best for experimental work of this character, because it is more objective. If the usual criterion for the diastolic pressure is used by one examiner, he will obtain results slightly different from those obtained by other examiners, unless all are trained together with the multiple-tube stethoscope.

The method employed gives results which would have been obtained by any competent examiner, with acute hearing, using the same method. The diastolic readings are all slightly lower than the average reading which might have been obtained by the other method, but since the relative, and not the absolute, measurements are important in this work, this is of no consequence. The greater objectivity and reliability of the method employed is important, however.

In estimating the heart rate, a count was made for fifteen seconds, and the result multiplied by four, to give rate per minute. No attempt was made to observe the character of the heart action.

The room temperature was kept fairly constant, the average being 70° for all subjects except reactor 2, for whom it was 69°, on account of the fact that the reactor came early in the morning. The temperature fluctuations did not exceed 3° above or below these averages in any case.

In each test, the reactor smoked one cigar or three cigarettes, commencing immediately after the twelfth blood pressure had been taken. As it was impossible to control the rate of smoking, without the introduction of psychological factors which might influence the blood pressure, the reactor was allowed to smoke until he had finished the cigar or the three cigarettes, as far as they could conveniently be smoked. No reactor at any time finished smoking before the nineteenth time-point, and no one smoked at any time beyond the twenty-sixth time-point. The time of cessation of smoking was recorded in each case. The stubs of the cigars and cigarettes were measured, and the approximate amount of each burned estimated by the method described in the first part of the report. The amounts consumed by each reactor in each day are given in table 20. The test continued for ten days with each reactor.

The procedure in the tests may be summarized as follows:

1. Arrival at the laboratory, 20 minutes rest in the chair.
2. Commencement of the blood pressure routine measurements: readings every three minutes until 8 readings had been taken (24 minutes).

3. Free association test, in place of the ninth reading (3 minutes).
4. Continuation of the blood pressure routine for three more readings (9 minutes).
5. Smoking commenced, cigar or cigarettes, and continued until one cigar or three cigarettes were consumed.
6. Fourteen more blood pressure readings taken (42 minutes).
7. Second free association test, in place of the twenty-seventh reading (3 minutes).
8. Three more blood pressure readings (9 minutes).

Total duration, 1 hour, 50 minutes: of blood pressure record, 1 hour, 30 minutes.

On two days of reactor 2, this procedure was not quite completed. On several days with different reactors, one or two extra readings were taken at the end of the period. The averages, however, are made for thirty readings only. In the case of reactor 10, unfortunately, the second free association test was on four days given at the twenty-eighth period instead of the twenty-seventh, which makes the average for both the twenty-seventh and twenty-eighth periods with this reactor unimportant.

The daily readings for each of the reactors are given in tables 21 to 26 inclusive. In each table the first column gives the actual time of day at which the three minute periods began. The second column gives the systolic pressure in millimeters of mercury; the third column gives the diastolic pressure; the fourth column gives the pulse-pressure, *i.e.*, the difference between the systolic and diastolic; and the fifth column gives the heart rate in beats per minute. In each case the heart rate was taken immediately after the systolic and diastolic readings. The blood pressure readings were made within the interval of a minute following the period for which the time is indicated: the pulse rate within the period of a minute and a half.

Certain uniform tendencies are discoverable in the results of the six subjects, and to make these tendencies more apparent, tables 27 to 32 inclusive, and figures 10 to 15 inclusive were prepared. In these tables are given the average readings of blood pressure and heart rate for each reactor for all ten days.

In these tables, for each subject, the first column presents, in order, the averages of the first reading on each of the ten days, the averages of the second reading, the averages of the third reading, and so on. Similar averages for diastolic and pulse pressure, and for the heart rate are given. These averages are plotted for each reactor in figures 10 to 15. The blood pressure readings are plotted in each case in millimeters of mercury, and the heart rate in beats per minute, the numerical values being indicated at the left of the charts. The gaps at A and B are the periods of the free association tests. The plus mark indicates the beginning of smoking, and the short vertical line the limits within which smoking ceased on the several days.

In every case, the systolic and diastolic pressures and the heart rates show an upward tendency shortly after the beginning of smoking, with a return towards "normal" with the cessation of smoking. The pulse pressures, indicated in the diagram by the difference between the systolic and diastolic graphs, are less uniform. The average rise is small in each case, but the uniformity might be significant.

The significance of variation in average readings, such as are presented in tables 27 to 32, and figures 10 to 15 can not in any case be determined from the averages alone. Nothing could be more fallacious than the assumption from these tables and diagrams alone, of a real and important effect of tobacco smoking upon blood pressure and heart rate. Not only the importance, but even the actuality of such an effect, must be determined by a further study of the detailed data. An average has only mathematical significance in any case until further significance has been demonstrated. Not only may averages, when taken alone, fail to show tendencies which are actually shown clearly in the data averaged, but in certain historical cases, tendencies apparently shown by averages have been completely absent from the data from which the averages were drawn.

In many cases the mean variation (average deviation) of averages furnishes accessory data which indicate the significance of the averages. In the case under consideration, this mean variation would be misleading, as will be pointed out below.

The methods of studying the detailed data are exemplified in figure 16. In this figure, the daily systolic readings of reactor 2 are plotted on the same axes: or rather, since the ten curves when superposed are not easily traceable unless colors are used, the values are plotted in two groups, the reading for the first five days in the first group, and the reading for the second five days in the second group. The axes are, however, the same in the two groups.

From a study of the systolic pressure readings of reactor 2, as given in table 21 or figure 16, several things are clear. First, there is great daily variation, in magnitude much greater than the maximal variation in the average readings of table 27 and figure 10. Second, in spite of these fluctuations, the tendency of the averages (table 27 and figure 10), is actually present in the measurements of days 3, 4, 6, 7, 8, 9, and 10, and there is nothing in the data of the other three days to indicate that the same tendency may not be present, but masked by the fluctuations due to other causes. Third, the temporal variations in these assumed tendencies, and the different average value of the pressure from day to day, make the mean variation which might be computed for each average of tables 27 to 32 of no significance.

The study of the data of tables 21 to 26 in detail is a tedious matter, and the presentation of the one hundred and eighty curves is not possible. The reader may either accept the author's conclusion that in the case of each of the six reactors the general tendency shown in figures 27 to 32 is actually present, and that these figures, while not demonstrating the tendency, nevertheless illustrate it: or he may check up the conclusion from the data of tables 21 to 26.

The importance of the apparent general effect of tobacco smoking upon blood pressure and heart rate, is a matter requiring separate consideration. Admitting the occurrence of a cardio-vascular adjustment occasioned by smoking, we must compare it with cardio-vascular adjustments, due to other causes which, as is clearly shown by figure 16 and by the tables, are going on concurrently. Although the effects of smoking apparently vary from day to day, they are not in general as large as those due to the other causes, and, manifestly, other causes must be at work to produce the apparent difference in the smoking effects, either by actually modifying the tobacco effect, or by an addition or subtraction of effects.

The variable causes at work are presumably of two sorts; (a) "physiological," that is: variation in bodily metabolism due to the state of health, digestion, etc., (b) "psychological," that is: variation in the stimulation from the environment and the consequent perceptual, ideational and emotional reactions. While the causes of the first class may account in part for the average daily levels, and may modify the effects of smoking, and of the psychological factors, the latter are probably the most important in these cases.

It may be assumed that some of the irregular variations were due to the fact that the reactor was not kept in absolute quiet, but that conversation was allowed, controlled by the experimenter. While the actual fluctuations are undoubtedly affected by the conversation, through the intellectual and emotional activities introduced, the fluctuations are no greater than are obtained under conditions where speech is not allowed. Investigations in this laboratory have shown that under the latter conditions, the irregular fluctuations are just as large as in the present data. Furthermore, when the reactor is kept in absolute quiet, the psychological conditions are actually more variable, varying from somnolence to intense ideational activity. The conditions under which these records were taken may, therefore, fairly be claimed to be the more "normal," although it is highly desirable that the effects of smoking, during periods of drowsiness, periods of sustained emotional excitement, and periods of mental and physical work, should later be investigated.

The irregular fluctuations in blood pressure from moment to moment under the ordinary conditions of experiment, shown clearly in tables 21 to 26, and in figure 16, explain the futility of the attempts to do experimental work with isolated or occasional readings. A single blood pressure reading before commencing to smoke, and a second reading a fixed number of minutes later, may show a rise in some subjects and a fall in others, although all may really react in the same general way. In working with untrained reactors, to whom the mere technique of the readings may be exciting, artifactual results may readily be obtained. It is probable, in the light of these records, and others obtained by the same method of prolonged series of readings, that the application of this method to other problems, especially to the problems of fatigue and work, and to the problem of the cyclic sexual variation in women, not only will give reliable results where none are obtainable by the method of occasional readings, but will also reveal unsuspected features of cardio-vascular adjustment.

The immediate rise in blood pressure and in heart rate produced by smoking is not so far shown to be due to the absorbed smoke-products. The psychological activities involved in the smoking process are without doubt important. We do not yet know, for example, what general effect upon blood pressure would be produced if the reactor, previously unoccupied, were caused to cut out paper-dolls for a period of time comparable to that occupied by smoking in these tests. In fact, we have little systematic knowledge of the relation of blood pressure changes to psychological processes, and although the obtaining of this knowledge by the general procedure used in this research is quite possible, it involves an enormous amount of time and labor, and needs a provision of funds quite beyond those we are able to obtain at present.

It was thought possible to obtain some check on the psychological factor by causing reactors to go through the smoking process without obtaining the usual tobacco products. Experiments with "denatured" tobacco showed at once that reactors with even a slight acquaintance with tobacco immediately detected the fraud, and the possibility of substituting warm air for smoke, with reactors of the grade of intelligence we used, is clearly zero. These methods of control were therefore not undertaken.

The results of this part of the investigation may be summarized as follows:

The effects, on healthy young adult reactors, of smoking a cigar or three cigarettes, are to produce a rise in systolic and diastolic blood pressure, and in heart rate. This rise varies in amount and in rapidity, from reactor to reactor, and from day to day for the same reactor. The rises in blood pressure usually amount to but a few millimeters, above the previous average level, and are in almost all cases less than ten, but may in some cases be over twenty millimeters. The rise in heart rate is irregular; less than ten per second in most cases, but may be as much as twenty. The normal irregular variations in blood pressure, due to various causes, are practically as great as the variations which may be ascribed to tobacco, but the normal variations in heart rate are less significant than the tobacco effects.

The blood pressures and heart rate subside to "normal" in from twenty to thirty minutes. In some cases this subsidence occurs before the finishing of the cigar or cigarettes: in other cases, the decline does not appear, and the rise may even be continued, for some minutes after the cessation of smoking. In other cases, the cessation of smoking is marked by an immediate decline in blood pressures and heart rate. While it seems probable that the time elapsing after the beginning of smoking is a more important factor than the discontinuance, this can not be clearly made out from the records so far obtained.

How far this effect is due to absorbed smoke-products, and how much to the psychological factors involved in the smoking process, remains to be discovered. Provision for extensive psychological work on blood pressure is urgently needed.

TABLE 20

Smoking schedules of reactors, indicating grams of tobacco consumed for each day's test

DATE	REACTOR					
	1 Cigarettes	2 Cigars	3 Cigars	4 Cigarettes	5 Cigars	6 Cigarettes
January 10	2.489					
January 11	2.178		4.114			
January 12		3.586				
January 13		4.466				
January 14				2.437		
January 15				2.489		
January 17	2.697	4.817				
January 18	2.437		4.114			
January 19		5.168				
January 20			4.114		4.114	
January 22				2.489		
January 24	2.697	4.114				
January 25	2.641					2.437
January 26					3.763	2.489
February 2						2.541
February 7	2.541	4.466				
February 8	2.489		3.763			2.541
February 9				2.593		2.645
February 10			3.412		4.114	
February 11		4.817				
February 12				2.489		
February 14	2.437	4.817				
Feburary 15	2.437		3.588			2.593
February 16				2.489		2.593
February 17			3.763		4.466	
February 18		4.992				
February 19				2.385		
February 21		4.466				
February 23						2.645
February 24			4.466		4.817	
February 25					4.114	
February 26				2.282	4.114	
March 1			3.939			2.489
March 2				2.489		2.541
March 3			3.763		4.817	
March 6				2.385		
March 8					4.817	
March 9					4.466	

TABLE 21A

Reactor 2, first day, January 10, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

A. M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:17	102	60	42	72
9:20	104	60	44	68
9:23	106	62	44	68
9:26	98	62	36	64
9:29	98	62	36	64
9:32	100	60	40	66
	Free association test			
9:42	100	62	38	64
9:45	102	62	40	64
9:47	102	62	40	68
	Began smoking at 9:48			
9:50	104	62	42	64
9:53	98	64	34	64
9:56	98	64	34	60
9:59	102	62	40	64
10:02	104	64	40	64
10:05	104	64	40	64
	Ceased smoking at 10:07			
10:08	104	62	42	64
10:11	102	62	40	66
10:14	104	64	40	68
10:17	106	68	38	60
	Free association test			

TABLE 21B

Second day, January 11, 1921

8:55	112	68	44	72
8:58	110	64	46	72
9:01	110	64	46	72
9:03	110	62	48	72
9:06	106	62	44	68
9:09	104	62	42	68
9:12	108	62	46	68
9:15	106	62	44	68
9:18	Free association test			
9:21	108	62	46	68
9:24	104	62	42	68
9:27	108	62	46	68

TABLE 21B—*Continued*

A. M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
	Began smoking at 9:28			
9:30	108	62	46	64
9:33	96	60	36	64
9:36	96	62	34	72
9:39	100	62	38	66
9:42	102	62	40	64
9:45	104	62	42	64
9:48	104	64	40	76
9:51	106	66	40	72
9:54	102	62	40	76
	Ceased smoking at 9:56			
9:57	98	64	34	64
10:00	104	62	42	60
10:03	104	62	42	64
10:06	106	62	44	64
10:09	106	62	44	64
10:12	Free association test			
10:15	108	64	44	64
10:18	100	62	38	72

TABLE 21C

Reactor 2, third day, January 17, 1921

8:55	106	60	46	68
8:58	108	60	48	68
9:01	110	60	50	68
9:03	110	60	50	68
9:06	110	60	50	64
9:09	106	60	46	68
9:12	108	60	48	64
9:15	108	60	48	64
9:18	Free association test			
9:21	108	58	50	68
9:24	106	60	46	68
9:27	106	60	46	64
	Began smoking at 9:28			
9:30	108	60	48	60
9:33	108	62	46	64
9:36	106	60	46	64
9:39	108	62	46	60
9:42	106	62	44	60
9:45	110	64	46	68

TABLE 21C—*Continued*

A. M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:48	108	62	46	64
9:51	106	62	44	66
9:54	108	62	46	64
9:57	108	60	48	64
	Ceased smoking at 9:59			
10:00	110	64	46	64
10:03	110	66	44	66
10:06	110	64	46	68
10:09	110	64	46	64
10:12	Free association test			
10:15	112	66	46	68
10:18	110	66	44	64
10:21	112	68	44	68
10:24	110	66	44	64
10:27	108	66	42	62

TABLE 21D

Reactor 2, fourth day, January 18, 1921

8:54	106	62	44	64
8:57	106	60	46	68
9:00	108	62	46	68
9:03	110	62	48	64
9:06	108	64	44	68
9:09	108	60	48	64
9:12	106	64	42	68
9:15	104	60	44	68
9:18	Free association test			
9:21	106	58	48	68
9:24	108	62	46	70
9:27	106	62	44	68
	Began smoking at 9:28			
9:30	102	62	40	68
9:33	104	62	42	68
9:36	106	62	44	64
9:39	102	62	40	68
9:42	106	62	44	68
9:45	106	62	44	68
9:48	110	66	44	70
9:51	106	62	44	72
9:54	110	68	42	74
9:57	106	64	42	68
	Ceased smoking at 9:58			

TABLE 21D—*Continued*

A. M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:00	108	66	42	68
10:03	104	64	40	68
10:06	104	64	40	64
10:09	102	64	38	68
10:12	Free association test			
10:15	106	64	42	68
10:18	106	68	38	66
10:21	108	68	40	64

TABLE 21E

Reactor 2, fifth day, January 24, 1921

8:54	102	60	42	64
8:57	108	68	40	68
9:00	106	66	40	64
9:03	110	68	42	64
9:06	104	64	40	64
9:09	108	66	42	60
9:12	104	66	38	60
9:15	106	66	40	60
9:18	Free association test			
9:21	106	68	38	62
9:24	110	70	40	60
9:27	106	66	40	60
	Began smoking at 9:28			
9:30	106	68	38	68
9:33	110	70	40	68
9:36	106	70	36	64
9:39	110	70	40	60
9:42	102	70	32	64
9:45	106	72	34	62
9:48	106	74	32	64
9:51	110	72	38	60
9:54	106	72	34	64
9:57	110	74	36	64
	Discontinued smoking at 9:58			
10:00	112	74	38	62
10:03	110	72	38	62
10:06	106	74	32	60
10:09	104	74	30	62
10:12	Free association test			
10:15	110	80	30	60
10:18	108	70	38	64
10:21	108	70	38	56
10:24	108	70	38	60

TABLE 21F

Reactor 2, sixth day, January 25, 1921

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
8:54	108	70	38	68
8:57	108	70	38	72
9:00	108	70	38	70
9:03	108	64	44	68
9:06	100	64	36	68
9:09	102	66	36	70
9:12	104	66	38	70
9:15	100	64	36	68
9:18		Free association test		
9:21	102	66	36	60
9:24	106	68	38	62
9:27	108	68	40	64
		Began smoking at 9:28		
9:30	104	68	36	64
9:33	104	68	36	64
9:36	104	70	34	68
9:39	106	66	40	72
9:42	108	66	42	68
9:45	104	66	36	68
9:48	108	70	38	72
9:51	106	68	38	72
		Discontinued smoking at 9:52		
9:54	108	68	40	68
9:57	106	68	38	64
10:00	104	70	34	64
10:03	100	70	30	64
10:06	100	70	30	64
10:09	106	70	36	60
10:12		Free association test		
10:15	102	66	36	64
10:18	100	70	30	56
10:21	104	70	34	60

TABLE 21G

Reactor 2, seventh day, February 7, 1921

8:54	102	58	44	68
8:57	106	58	48	72
9:00	104	60	44	72
9:03	102	58	44	72
9:06	102	60	42	72

TABLE 21G—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:09	102	60	42	68
9:12	104	60	44	64
9:15	104	58	46	68
9:18	Free association test			
9:21	100	58	42	64
9:24	98	58	40	68
9:27	100	60	40	64
	Began smoking at 9:30			
9:30	102	60	42	68
9:33	100	62	38	64
9:36	102	62	40	76
9:39	102	64	38	72
9:42	106	62	44	72
9:45	102	64	38	76
9:48	104	64	40	72
9:51	106	64	42	70
9:54	104	66	38	76
	Discontinued smoking at 9:57			
9:57	106	64	42	76
10:00	100	64	36	72
10:03	98	60	38	76
10:06	98	62	36	72
10:09	102	62	40	76
10:12	Free association test			
10:15	106	60	46	70
10:18	96	60	36	76
10:21	98	60	38	68
10:24	100	60	40	72

TABLE 21H

Reactor 2, eighth day, February 8, 1921

8:54	98	62	36	62
8:57	102	64	38	60
9.00	100	64	36	60
9:03	100	62	38	60
9:06	98	64	34	64
9:09	96	64	32	58
9:12	98	64	34	58
9:15	100	64	36	64
9:18	Free association test			
9:21	96	64	32	56

TABLE 21H—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:24	96	62	34	60
9:27	96	62	34	60
	Began smoking at 9:30			
9:30	94	62	32	60
9:33	102	64	38	62
9:36	100	64	36	64
9:39	100	64	36	68
9:42	104	70	34	64
9:45	98	68	30	64
9:48	100	70	30	68
9:51	100	66	34	66
9:54	100	62	38	64
	Discontinued smoking at 9:55			
9:57	96	60	36	68
10:00	92	58	34	64
10:03	96	64	32	64
10:06	100	62	38	62
10:09	96	62	34	62
10:12	Free association test			
10:15	96	64	32	60
10:18	102	64	38	60
10:21	102	64	38	60
10:24	100	64	36	56

TABLE 21I

Reactor 2, ninth day, February 14, 1921

8:55	96	60	36	68
8:58	100	60	40	68
9:01	96	60	36	64
9:04	100	62	38	68
9:07	96	60	36	64
9:10	100	62	38	68
9:13	96	60	36	66
9:16	96	60	36	64
9:19	Free association test			
9:22	98	60	38	64
9:25	98	60	38	60
9:28	98	60	38	64
	Began smoking at 9:29			
9:31	98	60	38	72
9:34	106	62	44	72

TABLE 21I—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:37	104	66	38	70
9:40	104	66	42	66
9:43	102	66	44	68
9:45	106	68	38	72
9:48	106	70	36	68
9:51	102	64	38	68
9:54	104	66	38	68
	Discontinued smoking at 9:55			
9:57	100	70	30	64
10:00	100	64	36	64
10:03	98	66	32	68
10:06	98	60	38	64
10:09	96	62	34	66
10:12	Free association test			
10:15	102	62	40	68
10:18	100	62	38	64
10:21	98	64	34	72

TABLE 21J

Reactor 2, tenth day, February 15, 1921

8:55	90	56	34	64
8:58	92	58	34	64
9:01	90	58	32	64
9:04	90	58	32	60
9:07	90	58	32	68
9:10	90	58	32	64
9:13	90	56	34	60
9:16	90	58	32	64
9:19	Free association test			
9:22	90	60	30	60
9:25	90	58	32	62
9:28	96	60	36	56
	Began smoking at 9:31			
9:31	96	64	32	64
9:34	94	64	30	60
9:37	96	66	30	64
9:40	94	66	28	68
9:43	94	66	28	64
9:46	94	62	32	64
9:49	94	66	28	68
9:52	92	64	28	64

TABLE 21J—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:55	96	64	32	68
9:58	96	66	30	72
	Discontinued smoking at 10:00			
10:01	100	64	36	66
10:04	96	64	32	66
10:07	90	60	30	68
10:10	90	60	30	60
10:13	Free association test			
10:16	94	60	34	60
10:19	90	60	30	60
10:22	92	58	34	62

TABLE 22A

Reactor 5, first day, January 12, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	110	62	48	60
2:28	110	66	44	58
2:31	114	64	50	60
2:34	116	70	46	60
2:37	114	68	46	60
2:40	114	68	46	58
2:43	114	68	46	56
2:46	112	68	44	60
2:49	Free Association test			
2:52	112	74	38	60
2:55	114	70	44	60
2:58	110	70	40	60
	Began smoking at 2:59			
3:01	112	70	42	60
3:04	118	72	46	68
3:07	116	80	36	64
3:10	118	80	38	72
3:13	122	78	44	72
3:16	122	78	44	68
3:19	122	76	46	72
3:22	122	78	46	64
3:25	124	78	46	68
3:28	136	82	54	72
	Discontinued smoking at 3:30			
3:31	124	78	46	68
3:34	126	78	48	72
3:37	130	82	48	68
3:40	124	78	46	68
3:43	Free association test			
3:46	128	78	50	76
3:49	124	78	46	72
3:52	122	74	48	64

Reactor smoked one cigar (3.58 grams of tobacco)

TABLE 22B

Reactor 5, second day, January 13, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	110	72	38	60
2:28	110	68	42	60
2:31	110	70	40	60
2:34	110	72	38	62
2:37	112	70	42	60
2:40	114	70	44	62
2:43	114	72	42	60
2:46	108	70	38	60
2:49	Free association test			
2:52	112	72	40	64
2:55	110	72	38	60
2:58	110	72	38	60
	Began smoking at 2:59			
3:01	110	72	38	60
3:04	116	72	44	60
3:07	114	74	40	64
3:10	114	74	40	62
3:13	118	82	36	62
3:16	120	82	38	64
3:19	116	78	38	64
3:22	118	80	38	62
3:25	118	82	36	64
	Discontinued smoking at 3:28			
3:28	120	86	34	68
3:31	120	82	38	64
3:34	118	80	38	60
3:37	120	84	36	64
3:40	120	82	38	64
3:43	118	82	36	64
3:46	Free association test			
3:49	122	80	42	68
3:52	120	80	40	64
3:55	118	80	38	64

TABLE 22C

Reactor 5, third day, January 17, 1921

1:25	110	58	52	60
1:28	110	58	52	64
1:31	112	66	46	74
1:34	112	60	52	60
1:37	112	60	52	60

TABLE 22C—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
1:40	110	60	50	60
1:43	112	60	52	66
1:46	112	60	52	66
1:49	Free association test			
1:52	112	58	54	60
1:55	108	60	48	66
1:58	110	60	50	64
	Began smoking at 1:58			
2:01	104	64	40	60
2:04	114	70	44	60
2:07	118	70	48	60
2:10	118	70	48	64
2:13	122	70	52	68
2:16	122	70	52	60
2:19	118	70	48	64
	Discontinued smoking at 2:20			
2:22	120	68	52	72
2:25	116	66	50	60
2:28	112	68	44	68
2:31	110	72	38	80
2:34	114	68	46	68
2:37	114	68	46	64
2:40	114	68	46	64
2:43	Free association test			
2:46	118	66	52	72
2:49	114	64	50	64
2:52	112	64	48	64

TABLE 22D

Reactor 5, fourth day, January 19, 1921

2:25	110	64	56	60
2:28	116	66	50	62
2:31	116	66	50	68
2:34	116	62	54	64
2:37	114	64	50	68
2:40	116	66	50	64
2:43	118	66	52	64
2:46	114	66	48	68
2:49	Free association test			
2:52	116	62	54	60
2:55	120	70	50	60

TABLE 22D—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:58	118	70	48	64
		Began smoking at 3:00		
3:01	118	70	48	64
3:04	114	70	44	64
3:07	116	70	46	68
3:10	116	70	46	68
3:13	120	74	46	64
3:16	116	68	48	72
3:19	118	74	44	66
		Discontinued smoking at 3:20		
3:22	118	74	44	68
3:25	120	70	50	72
3:28	126	70	56	76
3:31	128	70	58	64
3:34	120	70	50	66
3:37	116	66	50	68
3:40	118	68	50	68
3:43		Free association test		
3:46	116	70	56	64
3:49	114	62	52	62
3:52	118	62	56	64
3:55	116	60	56	64

TABLE 22E

Reactor 5, fifth day, January 24, 1921

1:25	120	60	60	66
1:28	120	60	60	68
1:31	122	58	64	68
1:34	122	62	60	76
1:37	122	58	64	76
1:40	118	62	56	72
1:43	120	60	60	72
1:46	120	60	60	72
1:49		Free association test		
1:52	118	60	58	68
1:55	114	58	56	66
1:58	114	62	52	68
		Began smoking at 2:00		
2:01	118	66	52	64
2:04	120	70	50	62
2:07	120	66	54	76

TABLE 22E—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:10	122	64	58	68
2:13	122	62	60	72
2:16	122	70	52	82
2:19	130	72	58	80
2:22	130	74	56	80
	Discontinued smoking at 2:25			
2:25	124	72	52	72
2:28	124	70	54	80
2:31	120	70	50	72
2:34	120	70	50	80
2:37	130	70	60	68
2:40	124	70	54	72
2:43	Free association test			
2:46	120	70	50	68
2:49	120	70	50	76
2:54	120	70	50	84

TABLE 22F

Reactor 5, sixth day, February 7, 1921

1:25	108	60	48	72
1:28	108	60	48	66
1:31	108	60	48	68
1:34	108	60	48	72
1:37	110	56	54	68
1:40	106	56	50	68
1:43	108	60	48	68
1:46	106	60	46	68
1:49	Free association test			
1:52	106	56	50	68
1:55	108	60	48	68
1:58	108	60	48	64
	Began smoking at 2:00			
2:01	106	60	46	60
2:04	110	56	54	64
2:07	108	60	48	60
2:10	108	62	46	72
2:13	112	62	50	68
2:16	112	66	46	68
2:19	112	62	50	72
2:22	112	64	48	64
2:25	114	74	40	68
	Discontinued smoking at 2:27			

TABLE 22F—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:28	114	76	38	64
2:31	112	66	46	68
2:34	108	62	46	76
2:37	112	66	46	72
2:40	114	64	50	64
2:43	Free association test			
2:46	110	66	44	68
2:49	112	62	50	64
2:52	108	60	48	68

TABLE 22G

Reactor 5, seventh day, February 11, 1921

1:25	112	58	54	68
1:28	108	56	52	60
1:31	110	60	50	68
1:34	108	60	48	68
1:37	110	60	50	64
1:40	110	58	52	60
1:43	104	56	48	64
1:46	106	58	48	64
1:49	Free association test			
1:52	106	58	48	60
1:55	112	60	52	60
1:58	110	60	50	64
	Began smoking at 2:00			
2:01	110	66	44	60
2:04	112	62	50	64
2:07	112	62	50	72
2:10	116	64	52	80
2:13	118	62	56	68
2:16	116	68	48	72
2:19	122	68	54	64
	Discontinued smoking at 2:21			
2:22	120	68	52	76
2:25	110	62	48	72
2:28	110	62	48	72
2:31	112	62	50	68
2:34	112	62	50	68
2:37	110	60	50	72
2:40	116	66	50	68
2:43	Free association test			
2:46	112	62	50	68
2:49	116	58	58	72
2:52	116	60	56	68

TABLE 22H

Reactor 5, eighth day, February 14, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
1:25	114	62	52	64
1:28	114	64	50	64
1:31	114	60	54	64
1:34	108	58	50	64
1:37	108	58	50	64
1:40	104	58	46	64
1:43	104	58	46	64
1:46	100	56	44	64
1:49	Free association test			
1:52	104	58	46	60
1:55	110	60	50	60
1:58	104	60	44	60
	Began smoking at 2:00			
2:01	110	66	44	72
2:04	110	64	46	62
2:07	112	68	44	68
2:10	118	68	50	66
2:13	112	68	44	64
2:16	116	68	48	64
2:19	114	68	46	64
2:22	110	66	44	62
2:25	112	70	42	72
	Discontinued smoking at 2:26			
2:28	112	70	42	64
2:31	110	66	44	60
2:34	112	62	50	64
2:37	110	64	46	62
2:40	108	62	46	64
2:43	110	64	46	60
2:46	Free association test			
2:49	114	66	48	60
2:52	110	66	44	60
2:55	114	68	46	

TABLE 22I

Reactor 5, ninth day, February 18, 1921

2:25	110	60	50	74
2:28	110	60	50	68
2:31	108	58	50	68
2:34	112	60	52	64
2:37	112	58	54	68

TABLE 22I—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:40	112	60	52	68
2:43	110	60	50	72
2:46	108	58	50	68
2:49	Free association test			
2:52	110	58	52	64
2:55	106	58	48	64
2:58	104	58	46	66
	Began smoking at 3:01			
3:01	106	62	44	56
3:04	110	64	46	60
3:07	112	66	46	64
3:10	110	66	44	68
3:13	114	70	44	74
3:16	112	68	44	70
3:19	114	68	46	64
3:22	114	70	44	64
3:25	112	68	44	68
3:28	116	74	42	68
	Discontinued smoking at 3:31			
3:31	118	70	48	80
3:34	110	68	42	76
3:37	110	68	42	64
3:40	106	66	40	66
3:43	106	68	38	68
3:46	Free association test			
3:49	106	62	44	64
3:52	106	62	44	72
3:55	108	60	48	68

TABLE 22J

Reactor 5, tenth day, February 21, 1921

1:25	108	60	48	72
1:28	108	60	48	70
1:31	108	60	48	72
1:34	108	60	48	68
1:37	108	60	48	74
1:40	110	60	50	68
1:43	106	58	48	68
1:46	108	58	50	72
1:49	Free association test			
1:52	112	60	52	66

TABLE 22J—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
1:55	106	56	50	68
1:58	104	56	48	66
	Began smoking at 2:01			
2:01	108	60	48	64
2:04	110	60	50	68
2:07	108	60	48	66
2:10	110	64	46	66
2:13	110	64	46	80
2:16	116	70	46	84
2:19	116	70	46	78
2:22	116	68	48	80
2:25	112	66	46	76
2:28	116	70	46	80
	Discontinued smoking at 2:31			
2:31	116	72	44	84
2:34	108	60	48	78
2:37	112	62	50	72
2:40	112	60	52	72
2:43	Free association test			
2:46	112	70	42	84
2:49	112	66	46	68
2:52	116	68	48	80

TABLE 23A

Reactor 6, first day, January 11, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
1:25	110	78	32	76
1:28	110	76	34	74
1:31	112	80	32	72
1:34	112	70	42	68
1:37	110	72	38	72
1:40	114	70	44	72
1:43	108	68	40	76
1:46	112	70	42	68
1:49	Free association test			
1:52	106	68	38	64
1:55	104	74	30	68
1:58	106	72	34	64
	Began smoking at 1:59			
2:01	108	70	38	72
2:04	108	74	34	68
2:07	110	72	38	68
2:10	110	74	36	68
2:13	110	74	36	68
2:16	108	72	36	72
2:19	110	74	36	76
2:22	110	74	36	76
2:25	110	72	38	74
	Discontinued smoking at 2:28			
2:28	110	74	36	76
2:31	108	74	34	68
2:34	108	74	34	76
2:37	110	76	34	88
2:40	110	80	30	80
2:43	Free association test			
2:46	112	74	38	76
2:49	112	76	36	80
2:52	112	76	36	68
2:55	104	68	36	68

TABLE 23B

Reactor 6, second day, January 18, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	106	68	38	74
2:28	110	64	36	72
2:31	110	70	40	80
2:34	106	64	42	80
2:37	118	78	40	76
2:40	108	68	40	72
2:43	110	72	38	68
2:46	108	74	34	72
2:49	Free association test			
2:52	110	74	36	80
2:55	108	74	34	64
2:58	106	72	34	76
	Began smoking at 2:59			
3:01	106	70	36	70
3:04	108	72	36	76
3:07	108	70	38	72
3:10	114	74	40	72
3:13	116	74	42	76
3:16	112	74	38	72
3:19	112	70	42	76
3:22	112	70	42	80
3:25	112	70	42	80
3:28	114	74	40	72
3:31	112	72	40	76
	Ceased smoking at 2:30			
3:34	110	74	36	74
3:37	110	72	38	68
3:40	112	74	38	68
3:43	Free association test			
3:46	110	78	32	72
3:49	116	78	38	68
3:52	118	80	38	62

TABLE 23C

Reactor 6, third day, January 20, 1921

2:25	104	60	44	68
2:28	110	60	50	72
2:31	106	60	46	72
2:34	106	56	50	72
2:37	106	60	46	64

TABLE 23C—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:40	110	62	48	80
2:43	108	64	44	64
2:46	108	60	38	72
2:49	Free association test			
2:52	108	62	46	64
2:55	106	60	46	72
2:58	108	60	48	64
	Began smoking at 2:59			
3:01	106	64	42	64
3:04	110	60	50	64
3:07	110	62	48	68
3:10	108	66	42	80
3:13	106	64	42	72
3:16	106	66	40	72
3:19	108	66	42	80
3:22	110	68	42	70
3:25	110	70	40	76
3:28	110	64	46	80
3:31	108	70	38	76
	Discontinued smoking at 3:31			
3:34	112	70	42	76
3:37	110	70	40	72
3:40	108	64	44	64
3:43	Free association test			
3:46	112	60	52	68
3:49	104	64	40	64
3:52	102	68	34	68
3:55	104	70	34	72

TABLE 23D

Reactor 6, fourth day, February 8, 1921

2:25	110	56	54	76
2:28	108	58	50	84
2:31	108	60	48	82
2:34	108	60	48	88
2:37	110	62	48	84
2:40	110	64	46	84
2:43	108	62	46	80
2:46	108	64	44	72
2:49	Free association test			
2:52	108	70	38	72

TABLE 23D—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:55	108	70	38	72
2:58	110	70	40	68
	Began smoking at 3:00			
3:01	110	70	40	72
3:04	112	74	38	76
3:07	108	66	42	80
3:10	110	70	40	76
3:13	106	72	34	76
3:16	112	74	38	80
3:19	112	78	34	72
3:22	112	74	38	76
3:25	116	74	42	72
3:28	120	78	42	76
3:31	118	78	40	80
	Discontinued smoking at 3:34			
3:34	118	78	40	76
3:37	118	74	44	76
3:40	114	70	44	76
3:43	Free association test			
3:46	114	74	40	76
3:49	108	72	36	76
3:52	110	72	38	76

TABLE 23E

Reactor 6, fifth day, February 10, 1921

2:25	114	60	54	88
2:28	114	62	52	84
2:31	116	62	54	86
2:34	116	64	52	88
2:37	118	62	56	88
2:40	116	64	52	84
2:43	116	62	54	84
2:46	116	60	56	82
2:49	Free association test			
2:52	112	60	52	82
2:55	106	60	46	88
2:58	110	62	48	80
	Began smoking at 3:00			
3:01	116	60	56	76
3:04	116	60	56	76
3:07	112	60	52	84

TABLE 23E—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
3:10	112	60	52	84
3:13	112	60	52	90
3:16	112	60	52	88
3:19	114	60	54	96
3:22	118	64	54	100
3:25	116	62	54	100
3:28	114	62	52	104
3:31	114	62	52	100
3:34	114	62	52	100
	Ceased smoking 3:35			
3:37	110	60	50	104
3:40	116	62	54	100
3:43	Free association test			
3:46	118	68	50	88
3:49	112	70	42	100
3:52	112	70	42	90

TABLE 23F

Reactor 6, sixth day, February 15, 1921

2:25	112	60	52	68
2:28	112	62	50	76
2:31	112	62	50	74
2:34	110	62	48	72
2:37	110	62	48	80
2:40	104	60	44	76
2:43	108	62	46	72
2:46	110	62	48	72
2:49	Free association test			
2:52	108	62	46	70
2:55	108	62	46	68
2:58	100	56	44	66
	Began smoking at 3:00			
3:01	110	64	46	70
3:04	104	60	44	64
3:07	108	62	46	80
3:10	104	60	44	76
3:13	106	60	46	76
3:16	106	64	42	80
3:19	106	64	42	80
3:22	106	64	42	76
3:25	112	64	48	80

TABLE 23F—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
3:28	112	66	46	84
	Discontinued smoking at 3:30			
3:31	112	64	48	74
3:34	106	62	44	76
3:37	108	64	44	76
3:40	110	66	44	74
3:43	Free association test			
3:46	108	66	42	72
3:49	106	64	42	72
3:52	106	60	46	84

TABLE 23G

Reactor 6, seventh day, February 17, 1921

2:25	106	66	40	68
2:28	108	70	38	68
2:31	100	64	36	66
2:34	102	60	42	64
2:37	102	66	36	80
2:40	104	66	38	70
2:43	106	66	40	72
2:46	100	64	36	72
2:49	Free association test			
2:52	104	60	44	72
2:55	102	60	42	68
2:58	102	60	42	66
	Began smoking at 3:00			
3:01	102	64	38	72
3:04	100	64	36	64
3:07	104	66	38	68
3:10	104	66	38	68
3:13	104	68	36	76
3:16	106	66	40	72
3:19	106	66	40	76
3:22	106	68	38	64
3:25	108	72	36	68
3:28	110	74	36	68
	Discontinued smoking at 3:30			
3:31	108	72	36	68
3:34	108	72	36	70
3:37	106	70	36	72
3:40	104	66	38	64
3:43	Free association test			
3:46	98	64	34	76
3:49	100	64	36	72
3:52	100	64	36	64

TABLE 23H

Reactor 6, eighth day, February 24, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	110	66	44	70
2:28	108	64	44	64
2:31	108	64	44	64
2:34	108	66	42	64
2:37	108	66	42	62
2:40	110	66	44	62
2:43	106	64	42	60
2:46	104	62	42	62
2:49	Free association test			
2:52	106	60	46	62
2:55	104	62	42	76
2:58	110	68	42	60
	Began smoking at 3:00			
3:01	108	62	46	72
3:04	104	62	42	64
3:07	106	64	42	72
3:10	110	64	46	68
3:13	108	66	42	76
3:16	104	62	42	64
3:19	100	58	38	76
3:22	106	62	44	76
3:25	110	64	46	72
3:28	110	66	44	68
3:31	108	70	38	72
3:34	114	72	42	72
	Discontinued smoking at 3:35			
3:37	112	64	48	68
3:40	106	64	42	62
3:43	Free association test			
3:46	106	66	40	60
3:49	106	68	38	66
3:52	106	66	40	72

TABLE 23I

Reactor 6, ninth day, March 1, 1921

2:25	110	64	46	72
2:28	108	62	46	76
2:31	110	64	46	72
2:34	108	64	44	72
2:37	108	64	44	68

TABLE 23I—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:40	110	66	44	68
2:43	110	62	48	66
2:46	108	62	46	68
2:49	Free association test			
2:52	108	60	48	64
2:55	112	64	48	64
2:58	112	64	48	64
	Began smoking at 3:00			
3:01	110	66	44	72
3:04	112	64	48	66
3:07	116	68	48	64
3:10	110	66	44	70
3:13	112	72	40	80
3:16	114	72	42	76
3:19	114	72	42	72
	Discontinued smoking at 3:22			
3:22	112	72	40	64
3:25	112	62	50	62
3:28	112	64	48	68
3:31	112	62	50	74
3:34	110	64	46	72
3:37	108	64	44	74
3:40	110	70	40	68
3:43	Free association test			
3:46	112	66	46	72
3:49	108	68	40	76
3:52	108	64	44	70

TABLE 23J

Reactor 6, tenth day, March 3, 1921

1:55	116	66	50	84
1:58	116	64	52	88
2:01	116	62	54	88
2:04	118	64	54	84
2:07	114	64	50	82
2:10	114	62	52	84
2:13	118	66	52	80
2:16	110	62	48	82
2:19	Free association test			
2:22	110	60	50	80
2:25	110	60	50	84

TABLE 23J—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:28	114	60	54	76
	Began smoking at 2:30			
2:31	116	64	52	78
2:34	116	66	50	82
2:37	116	68	48	78
2:40	116	66	50	78
2:43	118	68	50	74
2:46	120	70	50	86
2:49	116	70	56	80
2:52	112	70	42	84
2:55	114	70	44	88
2:58	112	66	46	84
	Ceased smoking 3:01			
3:01	114	66	48	80
3:04	112	60	52	88
3:07	114	62	52	80
3:10	112	62	50	88
3:13	Free association test			
3:16	112	64	48	78
3:19	114	62	52	88
3:22	116	62	54	84

TABLE 24A

Reactor 8, first day, January 14, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	100	66	34	64
2:28	100	64	36	64
2:31	100	64	36	60
2:34	102	70	32	64
2:37	102	68	34	64
2:40	100	68	32	60
2:43	100	68	32	60
2:46	100	66	34	60
2:49	Free association test			
2:52	102	68	34	56
2:55	102	68	34	60
2:58	102	68	34	56
	Began smoking at 2:59			
3:01	100	66	34	64
3:04	100	68	32	60
3:07	100	68	32	60
3:10	100	68	32	60
3:13	100	68	32	60
3:16	100	66	34	64
3:19	100	66	34	64
3:22	100	70	30	62
3:25	100	68	32	60
	Discontinued smoking at 3:27			
3:28	100	68	32	60
3:31	100	68	32	64
3:34	102	72	30	64
3:37	100	70	30	56
3:40	100	70	30	60
3:43	Free association test			
3:46	100	72	28	68
3:49	100	70	30	60
3:52	100	68	32	60
3:55	100	68	32	80

TABLE 24B

Reactor 8, second day, January 15, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	100	60	40	64
2:28	100	60	40	64
2:31	100	60	40	64
2:34	100	58	42	62
2:37	100	60	40	62
2:40	100	60	40	62
2:43	106	62	44	64
2:46	102	62	40	68
2:49	Free association test			
2:52	102	62	40	68
2:55	104	60	44	66
2:58	104	60	44	66
	Began smoking at 2:59			
3:01	104	60	44	64
3:04	112	60	52	64
3:07	104	60	44	60
3:10	98	60	38	60
3:13	98	60	38	64
3:16	100	60	40	68
3:19	102	60	42	70
3:22	102	60	42	68
3:25	104	62	42	68
	Discontinued smoking at 3:26			
3:28	106	62	44	64
3:31	104	68	36	62
3:34	106	68	38	68
3:37	108	68	40	64
3:40	104	66	38	56
3:43	Free association test			
3:46	100	64	36	64
3:49	100	62	38	60
3:52	108	64	44	56
3:55	104	62	42	60

TABLE 24C

Reactor 8, third day, January 22, 1921

2:25	106	60	46	72
2:28	104	60	44	68
2:31	106	58	48	68
2:34	106	60	46	64

TABLE 24C—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:37	112	60	52	64
2:40	106	60	46	68
2:43	104	60	44	68
2:46	106	60	46	68
2:49	Free association test			
2:52	104	60	44	72
2:55	106	60	46	74
2:58	104	62	42	64
	Began smoking at 2:59			
3:01	104	60	44	72
3:04	110	62	48	68
3:07	106	64	42	70
3:10	110	66	44	76
3:13	112	68	44	76
3:16	112	66	46	76
3:19	112	64	48	76
3:22	116	64	52	74
3:25	118	64	44	68
3:28	122	66	46	68
3:31	116	66	50	72
3:34	124	66	58	76
	Discontinued smoking at 3:37			
3:37	118	64	54	76
3:40	112	60	52	80
3:43	Free association test			
3:46	106	60	46	76
3:49	116	70	46	76
3:52	122	66	56	72
3:55	120	66	56	74

TABLE 24D

Reactor 8, fourth day, February 9, 1921

2:25	96	50	46	72
2:28	98	52	46	68
2:31	100	54	46	68
2:34	100	54	46	68
2:37	100	54	46	68
2:40	100	52	48	68
2:43	100	56	44	64
2:46	100	54	46	72
2:49	Free association test			

TABLE 24D—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:52	100	52	48	68
2:55	96	54	42	68
2:58	98	54	44	64
	Began smoking at 2:59			
3:01	100	56	44	68
3:04	100	56	44	68
3:07	92	56	36	64
3:10	94	54	40	68
3:13	96	56	40	68
3:16	96	56	40	68
3:19	94	54	40	68
	Discontinued smoking at 3:22			
3:22	94	56	38	64
3:25	92	52	40	60
3:28	102	58	44	64
3:31	100	58	42	64
3:34	102	56	46	64
3:37	100	56	44	64
3:40	100	56	44	68
3.43	Free association test			
3:46	90	58	32	76
3:49	88	58	30	60
3:52	92	60	32	68

TABLE 24E

Reactor 8, fifth day, February 12, 1921

2:25	90	52	38	68
2:28	94	56	38	64
2:31	100	58	42	64
2:34	100	58	42	68
2:37	92	58	34	62
2:40	102	58	44	76
2:43	90	56	34	64
2:46	98	58	40	64
2:49	Free association test			
2:52	92	56	36	64
2:55	92	56	36	64
2:58	94	58	36	62
	Began smoking at 2:59			
3:01	86	56	30	62
3:04	90	56	34	60

TABLE 24E—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
3:07	94	58	36	60
3:10	102	60	42	64
3:13	94	58	36	64
3:16	94	58	36	62
3:19	100	60	40	68
3:22	90	56	34	66
3:25	90	56	34	68
3:28	100	58	42	60
3:31	92	56	36	60
	Discontinued smoking at 3:32			
3:34	102	62	40	64
3:37	100	60	40	60
3:40	102	60	42	60
3:43	Free association test			
3:46	100	62	38	72
3:49	90	58	32	60
3:52	90	58	32	64

TABLE 24F

Reactor 8, sixth day, February 16, 1921

2:25	90	56	34	64
2:28	94	56	38	70
2:31	88	56	32	64
2:34	90	54	36	62
2:37	90	56	34	72
2:40	92	56	36	62
2:43	92	56	36	64
2:46	90	56	34	64
2:49	Free association test			
2:52	90	56	34	72
2:55	92	56	36	68
2:58	92	56	36	60
	Began smoking at 3:01			
3:01	92	56	36	60
3:04	90	52	38	64
3:07	92	52	40	60
3:10	88	52	36	60
3:13	96	56	40	60
3:16	102	56	46	58
3:19	92	54	38	68
3:22	92	56	36	66

TABLE 24F—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
3:25	100	56	44	64
3:28	92	58	34	64
	Discontinued smoking at 3:31			
3:31	88	54	34	62
3:34	88	56	32	60
3:37	88	54	34	64
3:40	88	56	32	60
3:43	Free association test			
3:46	92	56	36	60
3:49	90	54	36	60
3:52	88	54	34	60

TABLE 24G

Reactor 8, seventh day, February 19, 1921

2:25	90	50	40	60
2:28	90	52	38	60
2:31	90	50	40	60
2:34	90	52	38	62
2:37	96	54	42	64
2:40	90	54	36	60
2:43	90	54	36	60
2:46	90	54	36	64
2:49	Free association test (omitted)			
2:52	94	54	40	60
2:55	90	60	30	60
2:58	90	58	32	60
	Began smoking at 3:00			
3:01	94	60	34	60
3:04	94	60	34	60
3:07	94	60	34	60
3:10	92	62	30	62
3:13	90	62	28	62
3:16	96	64	32	62
3:19	100	64	36	60
3:22	92	62	30	60
3:25	102	62	40	60
3:28	100	64	36	60
3:31	100	60	40	60
3:34	102	60	42	60
	Discontinued smoking at 3:34			
3:37	96	58	38	60

TABLE 24G—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
3:40	98	58	40	64
3:43	Free association test (omitted)			
3:46	96	56	40	64
3:49	94	56	38	60
3:52	94	58	36	60

TABLE 24H

Reactor 8, eighth day, February 26, 1921

2:25	100	60	40	72
2:28	100	60	40	76
2:31	102	60	42	76
2:34	102	60	42	72
2:37	102	60	42	76
2:40	102	60	42	80
2:43	100	60	40	76
2:46	100	60	40	76
2:49	Free association test			
2:52	102	60	42	72
2:55	98	58	40	68
2:58	100	56	44	68
	Began smoking at 3:00			
3:01	102	60	42	68
3:04	106	60	46	72
3:07	110	58	52	72
3:10	104	60	44	66
3:13	108	62	46	68
3:16	110	62	48	68
3:19	108	60	48	66
3:22	108	62	46	64
3:25	108	62	46	60
3:28	106	62	44	64
3:31	100	62	38	68
3:34	106	58	48	64
3:37	106	60	46	68
	Discontinued smoking at 3:38			
3:40	108	60	48	64
3:43	Free association test			
3:46	100	58	42	68
3:49	106	64	42	64
3:52	100	58	42	64

TABLE 24I

Reactor 8, ninth day, March 2, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:25	94	54	40	68
2:28	96	56	40	64
2:31	100	58	42	70
2:34	100	60	40	70
2:37	106	58	46	68
2:40	106	58	48	68
2:43	102	58	44	72
2:46	106	68	48	72
2:49	Free association test			
2:52	100	58	42	68
2:55	100	58	42	68
2:58	100	60	40	72
	Began smoking at 3:00			
3:01	102	60	42	72
3:04	108	62	44	68
3:07	110	60	50	64
3:10	106	60	46	74
3:13	112	62	50	68
3:16	110	60	50	80
3:19	112	60	52	68
3:22	110	62	48	66
3:25	110	58	52	68
	Discontinued smoking at 3:27			
3:28	112	62	50	68
3:31	106	56	50	66
3:34	104	58	46	66
3:37	106	60	46	60
3:40	110	60	50	64
3:43	Free association test			
3:46	102	58	44	64
3:49	110	64	46	72
3:52	106	62	44	64

TABLE 24J

Reactor 8, tenth day, March 5, 1921

2:25	102	58	44	72
2:28	102	58	76	76
2:31	102	58	44	70
2:34	102	58	44	70
2:37	102	58	44	72

TABLE 24J—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:40	102	58	44	72
2:43	102	60	42	72
2:46	104	58	46	72
2:49	Free association test			
2:52	94	56	38	72
2:55	92	58	34	72
2:58	98	58	40	66
	Began smoking at 3:00			
3:01	104	60	44	64
3:04	98	60	38	68
3:07	104	60	44	68
3:10	100	62	38	70
3:13	100	62	38	62
3:16	102	62	42	70
3:19	106	64	42	72
3:22	104	62	42	64
3:25	102	64	38	66
	Discontinued smoking at 3:28			
3:28	98	62	36	68
3:31	94	62	32	68
3:34	96	62	32	68
3:37	100	62	38	68
3:40	96	64	32	64
3:43	Free association test			
3:46	98	58	40	68
3:49	98	60	38	66
3:52	98	62	36	66

TABLE 25A

Reactor 9, first day, January 20, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:55	106	70	36	68
9:58	110	70	40	62
10:01	110	70	40	64
10:04	106	70	36	64
10:07	108	68	40	64
10:10	108	70	38	72
10:13	106	68	38	64
10:16	106	70	36	64
10:19	Free association test			
10:22	106	70	36	64
10:25	108	70	38	68
10:28	106	70	36	64
	Began smoking at 10:30			
10:31	108	70	38	64
10:34	114	76	38	68
10:37	110	70	40	60
10:40	110	76	34	60
10:43	110	70	40	68
10:46	110	70	40	68
10:49	110	76	34	68
10:52	112	76	36	76
10:55	108	72	36	72
10:58	112	78	34	64
	Discontinued smoking at 10:59			
11:01	106	70	36	68
11:04	108	70	38	64
11:07	110	72	38	64
11:10	106	74	32	72
11:13	Free association test			
11:16	106	74	32	64
11:19	106	74	32	62
11:22	108	80	28	64

TABLE 25B

Reactor 9, second day, January 26, 1921

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:55	110	70	40	76
9:58	110	70	40	72
10:01	108	70	38	68
10:04	110	70	40	72
10:10	100	68	32	72
10:13	102	68	34	72
10:16	104	68	36	68
10:19	Free association test			
10:22	110	70	40	76
10:25	110	70	40	70
10:28	110	72	38	76
	Began smoking at 10:30			
10:31	110	70	40	66
10:34	108	72	36	66
10:37	104	70	34	70
10:40	104	70	34	74
10:43	104	72	32	70
10:46	104	74	30	72
10:49	102	72	30	70
10:52	104	74	30	68
10:55	110	72	38	66
10:58	106	76	30	64
11:01	106	78	28	66
11:04	108	78	30	64
11:07	110	76	34	70
	Discontinued smoking at 11:09			
11:10	110	80	30	72
11:13	Free association test			
11:16	104	72	32	72
11:19	104	76	28	68
11:22	106	72	34	76

TABLE 25C

Reactor 9, third day, February 10, 1921

9:55	108	66	42	80
9:58	108	64	44	80
10:01	106	62	44	84
10:04	104	64	40	84
10:07	104	64	40	80
10:10	108	66	42	80

TABLE 25C—*Continued*

A. M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:13	106	66	40	80
10:16	106	64	42	84
10:19	Free association test			
10:22	104	64	40	76
10:25	102	64	38	80
10:28	100	62	38	80
	Began smoking at 10:30			
10:31	106	66	40	80
10:34	106	68	38	76
10:37	104	66	38	80
10:40	108	66	42	76
10:43	104	66	38	70
10:46	102	66	36	76
10:49	106	66	40	76
10:52	104	66	38	76
10:55	102	66	36	76
10:58	106	70	36	76
11:01	100	66	34	80
	Discontinued smoking at 11:03			
11:04	104	68	36	84
11:07	106	70	36	80
11:10	102	70	32	76
11:13	Free association test			
11:16	100	70	30	72
11:19	102	70	32	72
11:22	102	74	28	72

TABLE 25D

Reactor 9, fourth day, February 17, 1921

9:55	112	62	50	76
9:58	114	60	54	70
10:01	106	62	44	72
10:04	106	62	44	72
10:07	106	62	44	68
10:10	104	62	42	76
10:13	104	60	44	64
10:16	104	60	44	66
10:19	Free association test			
10:22	102	60	42	60
10:25	106	60	46	64
10:28	102	60	42	72
	Began smoking at 10:30			

TABLE 25D—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:31	108	62	46	68
10:34	106	64	42	72
10:37	110	64	46	68
10:40	108	64	44	76
10:43	106	64	42	72
10:46	108	66	42	76
10:49	108	64	44	74
10:52	108	66	42	76
10:55	108	64	44	80
10:58	112	66	46	80
	Discontinued smoking at 11:01			
11:01	108	66	42	84
11:04	108	66	42	76
11:07	108	66	42	80
11:10	110	68	42	76
11:13	Free association test			
11:16	106	66	40	68
11:19	104	66	38	72
11:22	106	66	40	72

TABLE 25E

Reactor 9, fifth day, February 24, 1921

9:55	104	68	36	64
9:58	108	70	38	72
10:01	106	72	34	68
10:04	110	72	38	64
10:07	108	70	38	60
10:10	108	72	36	64
10:13	108	72	36	64
10:16	106	68	38	64
10:19	Free association test			
10:22	106	68	38	64
10:25	108	70	38	72
10:28	106	70	36	60
	Began smoking at 10:30			
10:31	106	72	34	60
10:34	106	72	34	68
10:37	106	70	36	72
10:40	107	70	38	66
10:43	110	74	36	70
10:46	112	76	36	64

TABLE 25E—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:49	110	74	36	72
10:52	114	76	38	76
	Discontinued smoking at 10:54			
10:55	112	74	38	68
10:58	108	74	34	72
11:01	114	76	38	72
11:04	106	74	32	68
11:07	108	74	36	64
11:10	110	74	36	64
11:13	Free association test			
11:16	112	76	36	64
11:19	112	74	38	60
11:22	112	76	36	66

TABLE 25F

Reactor 9, sixth day, February 25, 1921

9:55	106	66	40	72
9:58	104	64	40	68
10:01	106	64	42	76
10:04	104	64	40	72
10:07	106	64	42	72
10:10	108	64	44	68
10:13	106	64	42	80
10:16	104	64	40	74
10:19	Free association test			
10:22	104	64	40	68
10:25	104	66	38	68
10:28	100	64	36	60
	Began smoking at 10:30			
10:31	104	66	38	58
10:34	102	66	36	64
10:37	106	66	40	68
10:40	106	66	40	64
10:43	110	70	40	72
10:46	106	72	34	72
10:49	110	72	38	68
10:52	108	70	38	70
10:55	106	70	36	76
10:58	108	72	36	78
	Discontinued smoking at 11:00			
11:01	110	72	38	72

TABLE 25F—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
11:04	108	70	38	72
11:07	108	72	36	76
11:10	106	70	36	68
11:13	Free association test			
11:16	104	68	36	76
11:19	108	70	38	68
11:22	112	70	42	70

TABLE 25G

Reactor 9, seventh day, February 26, 1921

9:55	100	62	38	68
9:58	100	62	38	64
10:01	100	62	38	64
10:04	96	62	34	64
10:07	98	62	36	60
10:10	98	60	38	64
10:13	96	60	36	72
10:16	94	62	32	60
10:19	Free association test			
10:22	94	62	32	64
10:25	94	62	32	72
10:28	94	62	32	62
	Began smoking at 10:29			
10:31	100	66	34	58
10:34	100	66	34	64
10:37	100	66	34	68
10:40	102	66	36	68
10:43	100	68	32	66
10:46	100	66	34	68
10:49	100	66	34	66
10:52	98	68	30	68
10:55	100	66	34	66
10:58	96	66	30	68
11:01	100	66	34	68
	Discontinued smoking at 11:02			
11:04	98	66	32	72
11:07	100	68	32	80
11:10	100	66	34	76
11:13	Free association test			
11:16	100	66	34	72
11:19	96	66	30	72
11:22	96	66	30	70

TABLE 25H

Reactor 9, eighth day, March 3, 1921

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:55	108	66	42	68
9:58	106	68	38	68
10:01	108	68	40	80
10:04	112	70	52	80
10:07	112	70	52	84
10:10	110	70	50	80
10:13	110	68	42	72
10:16	112	68	44	68
10:19	Free association test			
10:22	108	70	38	76
10:25	110	72	38	66
10:28	110	72	38	68
	Began smoking at 10:30			
10:31	112	70	42	72
10:34	110	72	38	72
10:37	110	74	36	68
10:40	110	72	38	70
10:43	112	74	38	70
10:46	112	74	38	68
10:49	112	74	38	72
10:52	114	76	38	76
	Ceased smoking at 10:54			
10:55	118	78	40	72
10:58	114	78	36	72
11:01	114	70	44	72
11:04	112	70	42	76
11:07	114	70	44	76
11:10	112	70	42	68
11:13	Free association test			
11:16	116	66	50	68
11:19	116	66	50	72
11:22	112	70	42	80

TABLE 25I

Reactor 9, ninth day, March 8, 1921

p m 2:25	108	60	48	80
2:28	110	60	50	78
2:31	108	60	48	76
2:34	110	62	48	78
2:37	110	62	48	80

TABLE 25I—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
2:40	106	58	48	76
2:43	108	58	50	70
2:46	102	58	44	68
2:49	Free association test			
2:52	104	58	46	78
2:55	110	62	48	80
2:58	104	60	44	72
	Began smoking at 3:00			
3:01	110	62	48	76
3:04	112	60	52	72
3:07	114	62	52	80
3:10	110	64	46	78
3:13	112	66	46	84
3:16	112	66	46	84
3:19	116	66	50	88
3:22	114	66	48	84
	Discontinued smoking at 3.24			
3:25	114	66	48	84
3:28	112	62	50	84
3:31	112	64	48	84
3:34	110	66	44	88
3:37	112	62	50	80
3:40	112	62	50	82
3:43	Free association test			
3:46	112	62	50	82
3:49	112	60	52	78
3:52	114	64	50	86

TABLE 25J

Reactor 9, tenth day, March 9, 1921

1:25	116	64	52	80
1:28	116	66	50	84
1:31	114	66	48	82
1:34	110	64	46	84
1:37	112	64	48	76
1:40	108	62	46	80
1:43	110	62	48	78
1:46	108	64	44	80
1:49	Free association test			
1:52	112	64	48	78
1:55	114	66	48	82

TABLE 25J—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
1:58	110	64	46	80
	Began smoking at 2:00			
2:01	112	62	50	80
2:04	114	66	48	80
2:07	112	64	48	80
2:10	112	64	48	78
2:13	114	64	50	84
2:16	112	66	46	80
2:19	114	66	48	84
2:22	114	66	48	88
	Discontinued smoking at 2:23			
2:25	108	64	44	88
2:28	110	66	44	84
2:31	110	64	46	80
2:34	108	64	44	80
2:37	112	66	46	84
2:40	110	62	48	80
2:43	Free association test			
2:46	106	62	44	84
2:49	106	62	44	76
2:52	110	66	44	82

TABLE 26A

Reactor 10, first day, January 23, 1921

Blood pressure, heart rate, duration of smoking period and interval for free association test

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:55	94	60	34	76
10:58	86	60	26	68
11:01	92	58	34	72
11:04	94	60	34	80
11:07	92	60	32	72
11:10	100	60	40	76
11:13	94	60	34	68
11:16	100	60	40	76
11:19	Free association test			
11:22	94	60	34	70
11:25	94	64	30	72
11:28	98	64	34	66
	Began smoking at 11:30			
11:31	104	68	36	68
11:34	100	60	40	74
11:37	96	62	34	72
11:40	100	60	40	76
11:43	104	66	38	72
11:46	104	60	44	76
11:49	104	64	40	76
11:52	100	60	40	76
11:55	102	60	42	76
11:58	104	64	40	72
12:01	104	64	40	72
	Discontinued smoking at 12:02			
12:04	100	68	32	70
12:07	100	66	34	72
12:10	98	60	38	72
12:13	102	60	42	72
12:16	Free association test			
12:19	96	60	36	64
12:22	96	60	36	64
12:25	96	60	36	64

TABLE 26B

Reactor 10, second day, January 26, 1921

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
9:55	100	64	36	76
9:58	102	60	42	76
10:01	104	60	44	76
10:04	94	56	38	76
10:07	100	56	44	80
10:10	98	58	30	76
10:13	104	58	46	80
10:16	102	58	44	80
10:19	Free association test			
10:22	100	58	42	76
10:25	104	58	46	80
10:28	102	58	44	84
	Began smoking at 10:30			
10:31	102	56	46	78
10:34	100	60	40	80
10:37	106	60	46	80
10:40	106	62	44	80
10:43	108	62	46	80
10:46	106	64	42	80
10:49	104	62	42	80
10:52	106	66	40	80
10:55	104	68	36	82
10:58	108	64	44	84
11:01	104	64	40	84
11:04	108	66	42	80
	Discontinued smoking at 11:05			
11:07	100	66	34	80
11:10	112	70	42	76
11:13	Free association test			
11:16	110	64	46	70
11:19	104	64	40	76
11:22	108	68	40	76

TABLE 26C

Reactor 10, third day, February 2, 1921

9:55	98	60	38	68
9:58	98	60	38	72
10:01	100	60	40	74
10:04	102	60	42	76
10:07	96	60	36	76

TABLE 26C—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:10	94	58	36	78
10:13	96	60	36	78
10:16	104	60	44	80
10:19	Free association test			
10:22	94	60	34	72
10:25	96	60	36	68
10:28	96	60	36	74
	Began smoking at 10:30			
10:31	104	60	44	80
10:34	106	62	44	76
10:37	110	64	46	72
10:40	102	62	40	76
10:43	100	60	40	76
10:46	102	60	42	84
10:49	110	64	46	84
10:52	110	60	50	84
10:55	100	60	40	80
10:58	100	60	40	76
11:01	104	60	44	84
	Discontinued smoking at 11:01			
11:04	100	60	40	80
11:07	106	62	44	80
11:10	94	58	36	84
11:13	102	58	44	80
11:16	Free association test			
11:19	98	56	42	76
11:22	90	60	30	84
11:25	104	60	44	76

TABLE 26D

Reactor 10, fourth day, February 8, 1921

10:55	92	62	30	72
10:58	90	62	28	76
11:01	92	62	30	70
11:04	92	62	30	76
11:07	92	60	32	72
11:10	94	60	34	68
11:13	94	60	34	72
11:16	90	60	30	70
11:19	Free association test			
11:22	86	56	30	68

TABLE 26D—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
11:25	92	58	34	68
11:28	92	62	30	68
	Began smoking at 11:30			
11:31	100	70	30	72
11:34	90	64	26	72
11:37	90	66	24	76
11:40	90	64	26	68
11:43	92	62	30	72
11:46	92	64	28	68
11:49	90	64	26	68
11:52	92	62	30	68
11:55	94	64	30	72
11:58	94	60	34	72
12:01	86	60	26	68
	Discontinued smoking at 12:04			
12:04	90	60	30	68
12:07	84	60	24	64
12:10	82	60	22	64
12:13	88	62	26	64
12:16	Free assoieation test			
12:19	88	58	30	68
12:22	90	60	30	68
12:24	86	58	28	72

TABLE 26E

Reactor 10, fifth day, February 9, 1921

9:55	92	50	42	80
9:58	90	54	36	82
10:01	90	54	36	80
10:04	86	56	30	100
10:07	90	56	34	84
10:10	94	58	36	76
10:13	92	58	34	80
10:16	92	58	34	82
10:19	Free association test			
10:22	92	52	40	74
10:25	92	56	36	76
10:28	90	56	34	74
	Began smoking at 10:30			
10:31	86	58	28	76

TABLE 26E—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:34	90	56	34	76
10:37	90	52	38	80
10:40	90	50	40	80
10:43	90	50	40	84
10:46	90	52	38	84
10:49	92	54	38	80
10:52	92	58	34	76
10:55	92	56	36	80
10:58	92	56	36	76
11:01	88	56	32	76
11:04	90	56	34	76
	Discontinued smoking at 11:05			
11:07	92	58	34	76
11:10	94	60	34	80
11:13	Free association test			
11:16	90	54	36	80
11:19	90	54	36	80
11:22	86	54	32	88

TABLE 26F

Reactor 10, sixth day, February 15, 1921

p.m.				
10:55	86	50	36	68
10:58	84	50	34	70
11:01	86	52	34	68
11:04	84	56	28	66
11:07	86	54	32	68
11:10	84	56	28	64
11:13	86	54	32	68
11:16	86	54	32	64
11:19	Free association test			
11:22	86	56	30	62
11:25	84	54	30	68
11:28	86	56	30	64
	Began smoking at 11:29			
11:31	88	58	30	66
11:34	86	56	30	72
11:37	90	56	34	72
11:40	90	56	34	68
11:43	90	54	36	80
11:46	90	58	32	72
11:49	92	58	34	80

TABLE 26F—*Continued*

P.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
11:52	90	58	32	74
11:55	92	60	32	70
11:58	90	54	36	76
	Discontinued smoking at 12:01			
12:01	92	60	32	72
12:04	82	54	28	68
12:07	90	58	32	64
12:10	90	58	32	64
12:13	Free association test			
12:16	90	56	34	68
12:19	90	58	32	64
12:22	90	58	32	68

TABLE 26G

Reactor 10, seventh day, February 16, 1921

a.m.				
9:55	90	56	34	76
9:58	88	54	34	76
10:01	90	54	36	74
10:04	90	54	36	72
10:07	90	54	36	80
10:10	92	58	34	82
10:13	92	58	34	80
10:16	90	54	36	76
10:19	Free association test			
10:22	90	54	36	74
10:25	92	54	38	68
10:28	92	54	38	68
	Began smoking at 10:30			
10:31	92	54	38	76
10:34	92	54	38	80
10:37	92	56	36	80
10:40	90	54	36	78
10:43	92	56	36	80
10:46	92	56	36	80
10:49	92	54	38	80
10:52	96	56	40	76
10:55	94	56	38	76
	Discontinued smoking at 10:58			
10:58	94	54	40	76
11:01	92	54	38	84
11:04	90	54	36	92

TABLE 26G—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:07	94	54	40	80
10:10	86	54	32	76
10:13	Free association test			
10:16	90	52	38	80
10:19	86	52	34	76
10:22	90	50	40	78

TABLE 26H

Reactor 10, eighth day, February 23, 1921

9:55	94	54	40	68
9:58	96	54	42	80
10:01	92	52	40	80
10:04	92	52	40	72
10:07	92	54	38	72
10:10	90	52	38	68
10:13	92	54	38	68
10:16	92	54	38	68
10:19	Free association test			
10:22	90	56	34	72
10:25	90	54	36	80
10:28	90	54	36	76
	Began smoking at 10:31			
10:31	90	54	36	76
10:34	84	54	30	68
10:37	90	60	30	68
10:40	106	64	42	68
10:43	100	62	38	68
10:46	96	58	38	68
10:49	98	60	38	68
10:52	96	58	38	72
10:55	96	60	36	76
10:58	102	58	44	68
11:01	96	60	36	68
	Discontinued smoking at 11:04			
11:04	98	62	36	60
11:07	90	60	30	68
11:10	96	60	36	68
11:13	94	60	34	72
11:16	Free association test			
11:19	90	60	30	76
11:22	92	62	30	80
11:25	96	60	36	68

TABLE 26I

Reactor 10, ninth day, March 1, 1921

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
11:15	98	62	36	64
11:18	92	62	30	66
11:21	94	60	34	68
11:24	94	60	34	64
11:27	98	62	36	62
11:30	94	60	34	64
11:33	98	62	36	68
11:36	92	64	28	68
11:39	Free association test			
11:42	96	62	34	62
11:45	96	62	34	64
11:48	92	62	30	64
	Began smoking at 11:50			
11:51	96	62	34	68
11:54	100	64	36	68
11:57	100	62	38	68
12:00	96	62	34	68
12:03	94	60	34	68
12:06	94	64	30	68
12:09	102	66	36	64
12:12	104	64	40	72
12:15	94	60	34	64
12:18	96	64	32	64
	Discontinued smoking at 12:20			
12:21	94	66	28	64
12:24	94	64	30	70
12:27	94	62	32	64
12:30	96	64	32	76
12:33	96	60	36	64
12:36	Free association test			
12:39	88	60	28	60
12:42	90	64	26	64
12:45	98	64	34	64

TABLE 26J

Reactor 10, tenth day, March 2, 1921

9:55	94	54	40	84
9:58	94	54	40	84
10:01	92	50	42	84
10:04	90	52	38	84

TABLE 26J—*Continued*

A.M. HOUR	BLOOD PRESSURE			HEART RATE
	Systolic	Diastolic	Pulse pressure	
10:07	92	54	38	88
10:10	92	54	38	82
10:13	94	54	40	84
10:16	92	54	38	80
10:19	Free association test			
10:22	90	52	38	78
10:25	90	52	38	84
10:28	90	54	36	80
	Began smoking at 10:30			
10:31	94	54	40	84
10:34	92	54	38	70
10:37	90	56	34	66
10:40	96	60	36	70
10:43	94	56	38	76
10:46	94	60	34	80
10:49	94	58	36	74
10:52	94	62	32	74
	Ceased smoking 10:54			
10:55	94	58	36	72
10:58	90	60	30	84
11:01	92	60	32	76
11:04	92	58	34	70
11:07	94	56	38	72
11:10	90	56	34	70
11:13	Free association test			
11:16	90	60	30	68
11:19	90	60	30	68
11:22	88	58	30	76

TABLE 27

Reactor 2

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	102.2	61.6	40.6	67.0
2	104.4	62.2	42.2	68.0
3	103.8	62.6	41.2	67.0
4	103.8	61.8	42.2	66.0
5	101.4	61.8	39.6	66.4
6	101.6	61.8	39.8	65.4
7	101.4	62.0	39.4	64.2
8	101.5	61.4	40.1	65.4
9	Free association test			
10	101.4	61.6	39.8	63.4
11	101.8	62.2	39.6	64.2
12	102.6	62.2	40.4	63.6
+	Began smoking			
13	102.2	62.8	39.4	65.0
14	102:2	63.8	38.4	65.0
15	101.8	64.6	37.2	66.6
16	102.8	64.4	38.4	66.4
17	103.4	65.0	38.4	65.6
18	103.4	65.2	38.2	67.0
19	104.4	66.8	37.6	68.6
20	103.6	65.0	38.6	67.6
—	—	—	—	—
21	104.2	65.6	38.6	69.0
22	103.2	65.6	37.6	66.8
—	—	—	—	—
23	103.4	65.0	38.4	65.0
24	101.8	65.0	36.8	66.4
25	101.4	64.2	37.2	65.0
26	101.4	64.4	37.0	64.6
27	Free association test			
28	104.0	65.0	39.0	64.6
29	100.2	64.6	35.6	64.6
30	103.0	65.2	37.8	63.8

TABLE 28

Reactor 5

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	111.2	61.6	49.6	65.6
2	111.4	61.8	49.6	64.0
3	112.2	62.2	50.0	67.0
4	112.0	62.4	49.6	65.8
5	112.2	61.2	51.0	66.2
6	111.4	61.8	49.6	64.4
7	111.0	61.8	49.2	65.4
8	109.4	61.4	48.0	66.2
9	Free association test			
10	110.8	61.6	49.2	63.0
11	110.8	62.4	48.4	63.2
12	109.2	62.8	46.4	63.6
+	Began smoking			
13	110.2	65.6	44.6	62.0
14	113.4	66.0	47.4	63.2
15	113.6	67.6	46.0	66.2
16	115.0	68.2	46.8	68.6
17	117.0	69.2	47.8	69.2
18	117.4	70.8	46.6	70.4
19	118.2	70.6	47.6	68.8
—	—	—	—	—
20	118.0	71.0	47.0	69.2
21	116.2	70.8	45.4	69.2
22	118.6	72.8	45.8	71.2
—	—	—	—	—
23	117.0	70.8	46.2	70.8
24	114.8	68.0	46.8	70.8
25	116.4	69.0	47.4	67.4
26	115.6	68.4	47.2	67.0
27	Free association test			
28	114.4	69.6	44.8	69.2
29	115.0	66.8	48.2	67.0
30	113.8	66.6	47.2	68.8

TABLE 29

Reactor 6

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	109.8	64.4	45.4	74.4
2	110.4	64.2	46.2	75.6
3	109.8	64.8	45.0	75.6
4	109.4	63.0	46.4	75.2
5	110.4	65.6	44.8	75.6
6	110.0	64.8	45.2	75.2
7	109.8	64.8	45.0	72.2
8	109.4	64.0	45.4	72.2
9	Free association test			
10	108.0	63.6	44.4	71.0
11	106.8	64.6	42.2	72.4
12	107.8	64.4	43.4	68.4
+	Began smoking			
13	109.2	65.4	43.8	71.8
14	109.0	65.6	43.4	70.0
15	109.8	65.8	44.0	74.8
16	109.8	66.2	43.6	74.0
17	110.0	67.8	42.2	76.4
18	110.0	68.0	42 0	76.2
19	109.8	67.8	42.0	78.8
—	—	—	—	—
20	110.4	68.8	41.6	76.2
21	112.0	68.0	44.0	77.2
22	112.4	68.8	43.6	78.0
23.	111.4	69.0	42.4	76.8
24	111.2	68.8	42.4	78.0
—	—	—	—	—
25	110.6	67.6	43.0	77.8
26	110.2	67.8	42.4	74.4
27	Free association test			
28	110.2	68.0	42.2	73.8
29	108.6	68.6	40.0	76.2
30	108.2	68.4	39.8	73.8

TABLE 30

Reactor 8

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	96.8	56.6	40.2	67.6
2	97.8	57.4	40.4	67.4
3	98.8	57.6	41.2	66.4
4	99.2	58.4	40.8	66.2
5	100.2	58.6	41.6	67.2
6	100.0	58.4	41.6	67.6
7	98.6	59.0	39.6	66.4
8	99.6	58.6	41.0	68.0
9	Free association test			
10	98.0	58.2	39.8	67.2
11	97.2	58.8	38.4	66.8
12	98.2	59.0	39.2	63.8
+	Began smoking			
13	98.8	59.4	39.4	65.4
14	100.8	59.6	40.2	65.2
15	100.6	59.6	40.0	63.8
16	99.2	60.4	38.8	66.0
17	100.6	61.2	39.4	65 2
18	102.2	61.0	41.2	67.6
19	102.6	60.6	42.0	68.0
—	—	—	—	—
20	100.8	61.0	39.8	65.4
21	102.6	60.4	42.2	63.6
22	103.8	62.0	41.8	64.0
23	100.0	61.0	39.0	64.6
24	103.2	61.8	41.4	65.4
25	102.2	61.2	41.0	64.0
—	—	—	—	—
26	101.8	61.0	40.8	64.0
27	Free association test			
28	98.4	60.2	38.2	67.2
29	99.2	61.6	37.6	63.8
30	99.8	61.0	38.8	65.4

TABLE 31

Reactor 9

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	107.8	65.2	42.6	73.2
2	108.6	64.4	44.2	71.8
3	107.2	65.4	41.8	72.4
4	106.8	66.0	40.8	73.4
5	106.4	65.4	41.0	71.6
6	106.0	65.2	40.8	73.2
7	105.8	64.6	41.2	71.2
8	104.6	64.6	40.0	69.6
9	Free association test			
10	105.0	65.0	40.0	70.4
11	106.6	66.2	40.4	72.2
12	104.2	65.6	38.6	69.4
+	Began smoking			
13	107.6	66.6	41.0	69.0
14	107.8	68.2	39.6	70.2
15	107.6	67.2	40.4	71.4
16	107.8	67.8	40.0	71.0
17	108.2	68.8	39.4	72.6
18	107.8	69.6	38.2	72.8
19	108.8	69.6	39.2	73.8
20	109.0	70.4	38.6	75.0
—	—	—	—	—
21	109.0	68.2	39.8	74.8
22	108.0	70.8	37.2	74.2
23	108.6	69.2	39.4	74.6
24	106.8	69.2	38.6	74.4
25	108.6	69.6	39.0	76.4
—	—	—	—	—
26	107.8	70.2	37.6	73.6
27	Free association test			
28	106.6	68.2	39.4	72.2
29	106.6	68.4	38.2	70.0
30	107.8	70.4	37.4	73.8

TABLE 32

Reactor 10 (woman)

Averages of blood pressure and heart rate for ten days

READING	SYSTOLIC	DIASTOLIC	PULSE PRESSURE	HEART RATE
1	93.8	57.2	36.6	73.2
2	92.0	57.0	35.0	74.2
3	93.2	56.2	37.0	74.6
4	91.8	56.8	35.0	76.6
5	92.8	57.0	35.8	75.8
6	93.2	57.4	35.8	73.4
7	94.2	57.8	36.4	74.6
8	94.0	57.6	36.4	74.4
9	Free association test			
10	91.8	56.6	35.2	70.8
11	93.0	57.2	35.8	72.8
12	92.8	58.0	34.8	71.8
+	Began smoking			
13	95.6	59.4	36.2	74.4
14	94.0	58.4	35.6	73.6
15	95.4	59.4	36.0	73.4
16	96.6	59.4	37.2	73.2
17	96.4	58.8	37.6	76.0
18	96.0	59.6	36.4	76.0
19	97.8	60.4	37.4	75.4
20	98.4	60.4	38.0	75.2
21	96.2	60.2	36.0	74.8
—	—	—	—	—
22	97.0	59.4	37.6	74.8
23	95.2	60.4	34.8	74.8
24	94.4	60.2	34.2	73.4
25	94.4	60.2	34.2	72.0
—	—	—	—	—
26	93.8	60.0	33.8	73.0
27	96.4	60.0	36.4	70.4
28	Free association test			
29	93.0	58.0	35.0	71.0
30	91.8	59.4	32.4	72.4
31	95.2	59.0	36.2	73.0

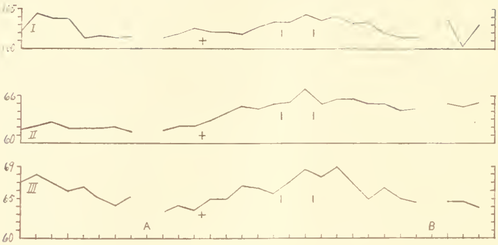

Fig. 10. Reactor 2

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

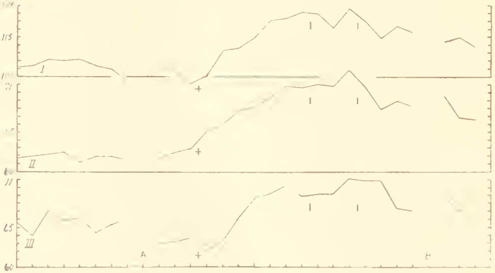

Fig. 11. Reactor 5

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

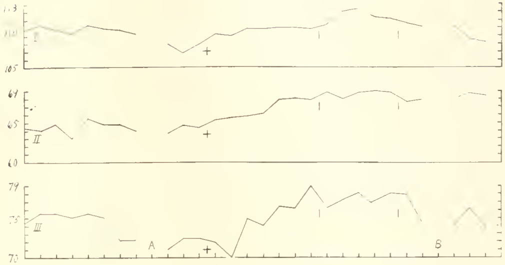

Fig. 12. Reactor 6

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

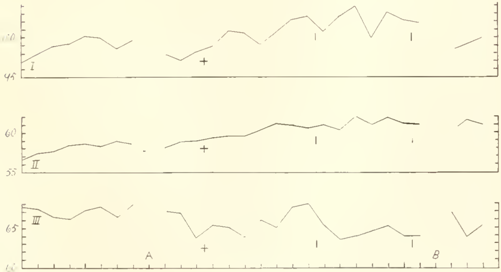

Fig. 13. Reactor 8

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

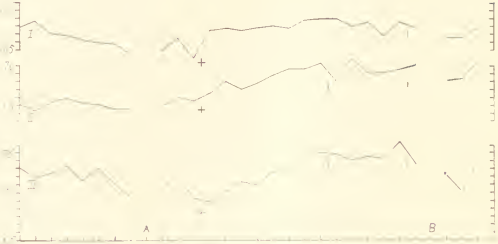

FIG. 14. REACTOR 9

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

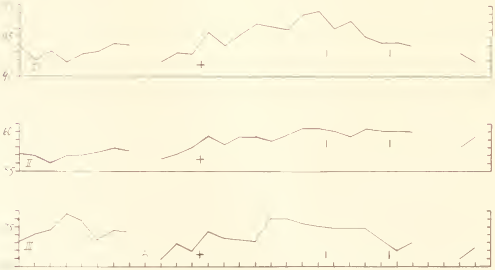

FIG. 15. REACTOR 10

Averages of systolic pressure (I) and diastolic pressure (II) in millimeters of mercury; and of heart rate (III) in beats per minute; for ten days.

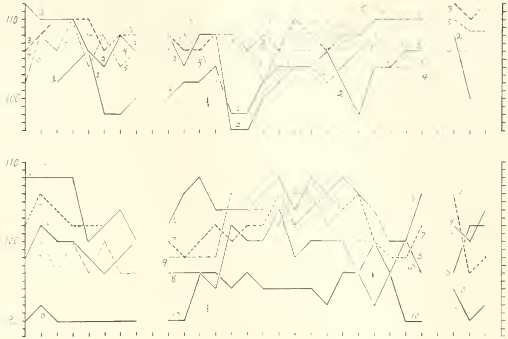

Fig. 16. Reactor 2

Daily readings (not averages) of systolic pressure, in millimeters of mercury. The numbers from 1 to 10 indicate the days.

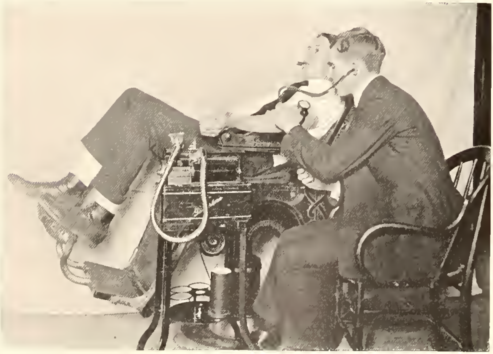

Fig. 17

Position of reactor for blood pressure and heart rate readings

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THE EFFECTS OF CIGAR AND CIGARETTE SMOKING ON CERTAIN PSYCHOLOGICAL AND PHYSIOLOGICAL FUNCTIONS

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III. FREE ASSOCIATION TESTS

Free association tests of the serial type were conducted in conjunction with the blood pressure and heart rate measurements reported in part II.[1] Two tests were given daily to each of the six reactors, the first test being started nine minutes before the beginning of smoking, and the second started fifty-four minutes later, from six to twenty minutes after the cessation of smoking. Each test lasted three minutes. The first test, therefore, came, in general, at a point where the blood pressure and heart rate were at "normal" resting values. The averages for the whole group for the ninth blood pressure readings (immediately before the first association test) were: systolic, 102.5; diastolic, 61.1; heart rate, 66.7. The group averages for the three readings (tenth, eleventh, and twelfth) just before the commencing of smoking were: systolic, 103.0; diastolic, 61.1; heart rate, 69.3. The second association test came, in general, before the effects of smoking on the blood pressure had disappeared, the group averages for the twenty-seventh reading (at the conclusion of the second association test) being: systolic, 106.9; diastolic, 65.3. But the average heart rate, by this time, had returned to practically the same value as at the first test, the group average being 69.0.

The association test consisted in giving to the reactor a "stimulus" word, and requiring him to respond immediately with the first word this stimulus word suggested to him, and to continue for three minutes to utter the words suggested by the preceding words. He thus gave expression to the series of ideas aroused by associations commencing with the stimulus word. The associations operative were "free" in the technical sense of the term, in that no restraints were placed upon the types of ideas, or on the directions the associations might take.

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[1] Journal of Comparative Psychology, vol. ii, no. 6, pp. 431–505.

The reactor spoke the words into the mouthpiece of a dictaphone, which was placed beside the chair in which he reclined, and thus a definite record of the words uttered was obtained. Previous to the test, the experimenter had spoken into the dictaphone the date and time, and the name of the reactor. At the proper moment for the test, the reactor slightly raised his head, as shown in figure 18; the mouthpiece was placed in his hand; the examiner spoke the stimulus word; and the reactor commenced to utter his associations.

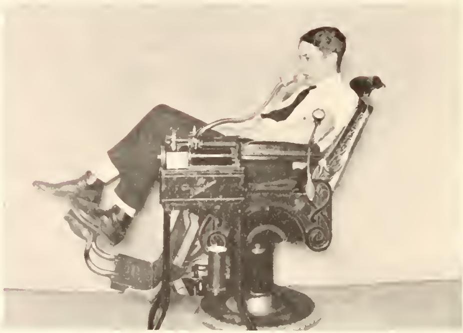

FIG. 18. POSITION OF THE REACTOR IN THE FREE ASSOCIATION TEST

The stimulus words were mostly adjectives and adverbs, so chosen as to give the reactor a start, independent of trains of thought which might be occupying his mind just before the beginning of the tests, and such as had little probability of bringing up directly emotional responses. The reactor was instructed to avoid sentence formation, counting, or other forms of reaction which might replace an associated train of ideas. At the end of the test, the stimulus word was recorded on the dictaphone cylinder by the experimenter. The cylinder, therefore, contained a complete record of the test.

After the work with a reactor was concluded, the records were transcribed. First, the actual words on the cylinder were written down. With few exceptions, the words recorded could be recognized when reproduced by the dictaphone. Next, the temporal positions of the words were obtained by the following method:

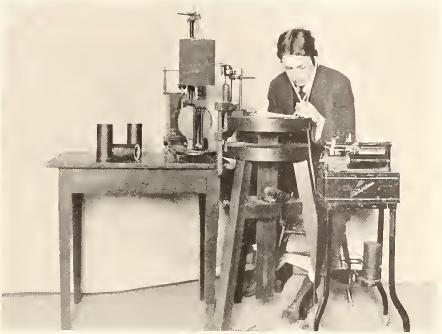

FIG. 19. SET-UP FOR TRANSCRIBING TIME RECORD FROM DICTAPHONE TO SMOKE DRUM

The experimenter, or a trained assistant, listened to the dictaphone reproduction, and tapped on a telegraph key the moment of beginning of each word. The telegraph key was electrically connected with a marker writing on a kymograph drum, on which a Jacquet chronograph wrote a time line in fifth-seconds. The dictaphone was set for the same rate of operation as was used in making the record; hence, the kymograph record gave in readable form the temporal distribution of the words, subject to the reaction-time variation of the transcriber. This variation was negligible for the purposes of the measurement. From the kymograph record, the correspondence of the transcribing rate to the original recording rate of the dictaphone could be checked, and in case of a deviation, the proper correction was simply made. The set-up for transcribing the time is shown in figure 19, and a section of a sample kymograph record in figure 20.

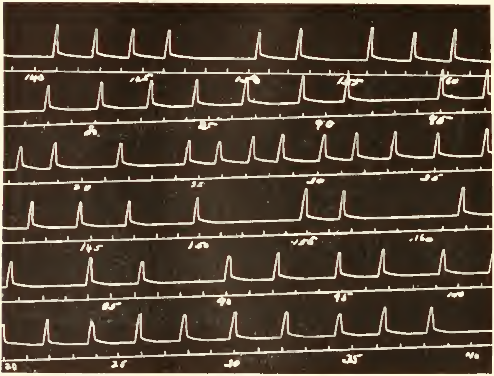

FIG. 20. SECTION OF KYMOGRAPH RECORD AS TRANSCRIBED FROM DICTAPHONE

The irregular line indicates word positions; the regular line, fifths of seconds

From the kymograph record, the temporal grouping of the words was obtained, and also the number of words in each quartile of the time. From the word lists, the distributions of parts of speech were obtained, although the determination was arbitrary in some cases, since certain words can be either nouns or verbs. The data so obtained are presented in tables 33 to 38.

In the interpretation of the tables, certain cautions, which will be detailed later, must be observed. But there are certain striking differences between the before-smoking and the after-smoking results. In the first place, the total number of words

TABLE 33

Free association tests. Reactor 2

	DATE										
	January 10	January 11	January 17	January 18	January 24	January 25	February 7	February 8	February 14	February 15	TOTALS
Before smoking											
Words		40	45	37	36	33	40	49	61	57	398
Nouns		38	42	29	34	31	39	44	59	49	365
Verbs				3							3
Adjectives		1	2	3		2	1	3	2	6	20
Adverbs		1									1
Prepositions								2		2	4
Unintelligible			1	2	2						5
Quartiles (words) 1		13	17	12	11	12	12	18	21	18	134
Quartiles (words) 2		9	12	9	9	5	12	11	13	14	94
Quartiles (words) 3		10	8	8	9	9	10	12	14	13	93
Quartiles (words) 4		9	8	8	7	7	6	8	13	12	78
A.D. for test (seconds)		2.25	2.20	2.43	2.50	2.72	2.25	1.84	1.47	1.57	2.03
A.D. of quartiles (words)											7.61
After smoking											
Words		47	40	39	31	39	44	50	65	65	420
Nouns		46	33	32	28	37	43	45	62	62	388
Verbs			4	1		1		2	1	1	10
Adjectives			1	4	1	1	1	2	2	2	14
Adverbs			1	1	1						3
Prepositions											
Unintelligible			1	1	1			1			4
Quartiles (words) 1		12	10	10	10	11	14	14	19	17	117
Quartiles (words) 2		12	8	11	6	10	9	13	14	15	98
Quartiles (words) 3		10	11	9	8	9	11	10	18	15	101
Quartiles (words) 4		13	10	9	7	9	10	13	14	18	103
A.D. for test (seconds)		1.92	2.25	2.31	2.91	2.31	2.05	1.80	1.35	1.39	1.93
A.D. of quartiles (words)											2.91

TABLE 34

Free association tests. Reactor 5

		DATE										
		January 12	January 13	January 17	January 19	January 24	February 7	February 11	February 14	February 18	February 21	TOTALS
Before smoking												
Words		3	12	58	66	78	88	91	93	102	97	688
Nouns			3	44	55	60	59	69	59	44	55	448
Verbs			1	4	1	4	11	2	5	20	15	63
Adjectives		3	8	6	9	9	12	10	20	22	21	120
Adverbs							1			3		4
Prepositions								4	7	10		21
Unintelligible				4	1	5	5	6	2	3	6	32
Quartiles (words)	1	2	8	24	17	23	29	26	28	27	24	208
	2		3	13	17	20	22	21	21	26	25	168
	3	1	1	13	14	18	21	22	23	28	26	167
	4			8	18	17	16	22	21	21	22	145
A.D. for test (seconds)		3.00	7 50	1.55	1.36	1.15	1 02	1.00	0.97	0.88	0.93	1.31
A.D. of quartiles (words)												7.20
After smoking												
Words		15	59	65	63	80	79	96	90	98	84	729
Nouns		11	47	58	39	70	52	62	51	57	42	489
Verbs		1	1	4	5	1	9	16	14	10	19	80
Adjectives		2	10	2	16	5	17	13	17	25	16	123
Adverbs					2				2	4		8
Prepositions								2	5	2	2	11
Unintelligible		1	1	1	1	4	1	3	1		5	18
Quartiles (words)	1	4	18	18	19	18	20	30	24	30	18	199
	2	2	13	18	15	20	24	26	23	22	23	186
	3	5	14	15	13	20	19	21	22	25	20	174
	4	4	14	14	16	22	16	19	21	21	23	170
A.D. for test (seconds)		6.00	1.53	1.38	1 43	1.12	1.14	0 93	1.00	0.92	1.07	1.24
A.D. of quartiles (words)												3.10

after smoking is greater than the total number before smoking in the case of five subjects. In the other case (reactor 6), the number after smoking is less.

TABLE 35

Free association tests. Reactor 6

	DATE									TOTALS
	January 11	January 18	January 20	February 8	February 10	February 16	February 17	February 24	March 1	
	Before smoking									
Words	74	82	82	108	87	85	76	83	94	771
Nouns	46	58	43	70	68	73	61	71	72	562
Verbs	6	2	6	9	3	6		1	5	38
Adjectives	15	17	27	14	10	5	8	10	10	116
Adverbs	3	2	6						1	12
Prepositions		2		10	3				4	19
Unintelligible	4	1		5	3	1	7	1	2	24
Quartiles (words) 1	21	27	31	33	26	29	23	25	31	246
Quartiles (words) 2	19	20	19	26	22	21	19	22	21	189
Quartiles (words) 3	17	19	16	23	20	18	18	20	22	173
Quartiles (words) 4	17	16	16	26	19	17	16	16	20	163
A.D. for test (seconds)	1.27	1.10	1.10	0.86	1.35	1.06	1.18	1.08	0.96	1.05
A.D. of quartiles (words)										10.82
	After smoking									
Words	54	82	68	96	82	78	85	99	93	737
Nouns	25	46	48	83	58	54	49	74	82	518
Verbs	6	1	5		3	5	3	3		26
Adjectives	13	34	12	7	18	16	15	15	8	138
Adverbs			2							2
Prepositions	6		1	5						12
Unintelligible	4	1		1	3	3	18	7	3	40
Quartiles (words) 1	14	27	19	28	25	23	27	29	30	222
Quartiles (words) 2	14	20	18	23	16	18	19	24	23	175
Quartiles (words) 3	14	15	14	22	18	18	20	23	20	164
Quartiles (words) 4	12	20	17	23	23	19	19	23	20	176
A.D. for test (seconds)	1.67	1.09	1.32	0.98	1.09	1.15	1.06	0.96	0.98	1.10
A.D. of quartiles (words)										8.22

If we consider the number of nouns, which might possibly be considered as a better index of discrete ideas, we find that this

TABLE 36

Free association tests. Reactor 8

	DATE					TOTALS
	January 15	January 16	February 26	March 2	March 6	
Before smoking						
Words	29	35	34	41	50	189
Nouns	16	13	13	9	24	75
Verbs	1	8	3	3	1	16
Adjectives	12	3	7	17	19	58
Adverbs			2	7		9
Prepositions		7	1	2		10
Conjunctions		1				1
Unintelligible				2	6	8
Quartiles (words) 1.	13	21	16	13	12	75
Quartiles (words) 2.	4	7	7	10	14	42
Quartiles (words) 3.	5	4	4	9	11	33
Quartiles (words) 4.	7	3	7	9	13	39
A.D. for test (seconds)	3.01	2.57	2.65	2.20	1.80	2.38
A.D. of quartiles (words)						11.10
After smoking						
Words	34	50	38	44	43	209
Nouns	21	35	20	18	15	109
Verbs	5	5	4	5	3	22
Adjectives	7	5	2		7	21
Adverbs		5		5		10
Prepositions				1		1
Unintelligible	1		4	8	18	31
Quartiles (words) 1.	13	14	13	18	14	72
Quartiles (words) 2.	9	15	9	16	16	65
Quartiles (words) 3.	6	12	9	3	8	38
Quartiles (words) 4.	6	9	7	7	5	34
A.D. for test (seconds)	2.65	1.80	2.37	2.05	2.09	2.15
A.D. of quartiles (words)						13.00

number is greater for all subjects but the one (reactor 6) who gives a smaller total number of words after smoking.[2] Certainly,

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[2] Reactors 6 and 9 were habitual smokers; reactor 5 was a little less regular in his smoking habits, and reactors 2, 8, and 10 were relatively abstainers, smoking only occasionally. Reactors 5, 6, and 9 smoked cigars in the tests: the other reactors smoked cigarettes.

TABLE 37

Free association tests. Reactor 9

	DATE									TOTALS
	January 20	February 10	February 17	February 24	February 25	February 26	March 3	March 8	March 9	
Before smoking										
Words	17	27	54	60	53	59	60	64	65	459
Nouns	14	21	48	45	40	36	45	54	44	347
Verbs		2	3	6	3	12	3	5	7	41
Adjectives	1			3	5	9	4	4	10	36
Adverbs		1	2		1	1	2			7
Prepositions		2						1	1	4
Unintelligible	2	1	1	6	4	1	6		3	24
Quartiles (words) 1.	11	11	19	21	14	18	17	22	17	150
2.	3	6	12	13	13	14	14	15	17	107
3.	3	9	11	14	12	12	14	16	17	108
4.		1	12	12	14	15	15	11	14	94
A.D. for test (seconds)	5.30	3.33	1.67	1.50	1.70	1.53	1.50	1.41	1.38	1.77
A.D. of quartiles (words)										7.83
After smoking										
Words	13	36	59	65	52	64	71	88	72	520
Nouns	7	18	53	43	30	42	55	61	56	370
Verbs	1	7	3	9	8	7	1	4	5	45
Adjectives	1	5	2	9	11	11	5	15	7	66
Adverbs		1	1				2	2	1	7
Prepositions	1	2		1				1		5
Pronouns							1	2		3
Unintelligible	3	3		3	3	4	7	3	3	29
Quartiles (words) 1.	6	7	19	19	15	17	23	24	24	154
2.		8	16	16	12	16	16	25	21	130
3.	4	11	12	17	15	16	16	20	16	127
4.	3	10	12	13	10	15	16	19	11	109
A.D. for test (seconds)	6.92	2.50	1.53	1.39	1.73	1.46	1.27	1.02	1.25	1.56
A.D. of quartiles (words)										5.35

the supposition (made by some writers) that an immediate effect of smoking is to inhibit the flow of ideas is given no support by these figures: rather the reverse.

If we consider the distribution of words in the quartiles of time, we find that after smoking, there is greater uniformity of distribution. Before smoking, the general tendency is to give a relatively large number of words in the first quartile, falling off

TABLE 38

Free association tests. Reactor 10

		DATE									TOTALS
		January 25	January 26	February 8	February 9	February 13	February 16	February 23	March 1	March 2	
Before smoking											
Words		72	58	32	27	43	35	31	52	27	377
Nouns		54	42	16	21	18	26	22	31	21	251
Verbs				4		1		1	9		15
Adjectives		18	15	3	3	23	5	6	4	3	80
Adverbs				4	2		1		1	1	9
Prepositions				2					2		4
Pronouns				1							1
Unintelligible			1	2	1	1	3	3	5	2	18
Quartiles (words)	1	21	19	13	13	12	16	12	19	10	135
	2	18	12	18	7	9	7	4	13	5	83
	3	20	14	8	2	11	6	7	5	3	76
	4	13	13	3	5	11	6	8	15	9	83
A.D. for test (seconds)		1.58	1.55	2.81	3.33	2.09	2.57	2.90	1.73	3.33	2.15
A.D. of quartiles (words)											9.06
After smoking											
Words		43	50	57	41	30	37	41	43	49	391
Nouns		19	41	51	26	16	24	30	34	33	274
Verbs		2		1	2	1	3	2			11
Adjectives		16	4	2	1	7	3	6	4	2	45
Adverbs		2	1	1	3	1	5			8	21
Prepositions				2	7	1				1	11
Unintelligible		4	4		2	4	2	3	5	5	29
Quartiles (words	1	18	16	17	14	6	13	13	15	13	125
	2	9	10	12	8	12	8	9	9	12	89
	3	5	12	17	9	8	9	8	11	10	89
	4	11	12	11	10	4	7	11	8	14	88
A.D. for test (seconds)		2.09	1.80	1.58	2.20	3.00	2.42	2.20	2.09	1.84	2.08
A.D. of quartiles											6.05

rapidly in the second and third. After smoking, although not reproducing as fast in the first quartile, the reactors in general hold up better in the later quartiles.

A numerical measure of the greater uniformity of distribution of words per quartile in the after-smoking tests is the average deviations of the quartiles. The average number of words per quartile is, of course, 25 per cent of the total number of words in any case. If we subtract this quartile average for each reactor from the actual word numbers for the quartiles of that reactor's distribution, and then obtain the average of these quartile deviations, the result is the quartile average deviation. It will be noted in the tables that this average deviation is smaller in the after-smoking tests than in the before-smoking, for each reactor except no. 8. This tendency towards greater uniformity of work after smoking is one which has already been recognized in other types of performance.

Another indication of greater uniformity of work after smoking is in the average deviations for the tests. These average deviations are measures of the irregularity of spacing of words in the records, and are obtained by first measuring the time-interval from the beginning of each word to the beginning of the next word in all the records; next averaging these intervals for each day's record; then obtaining the deviation of each interval from the average for the record; and finally averaging these deviations. The smaller deviation is therefore an index of greater uniformity in the spacing of the words: of more uniformity in the rate of associative recall. In the tables, the average deviation (A.D.) of the word-intervals are given for each day of the before and after-smoking tests, and finally the averages of these average deviations for the whole sets. And in all cases except one, the average deviation for the whole after-smoking set is less than the average for the before-smoking set. In the case of reactor 6 (who is also an exception in regard to total numbers of words and numbers of nouns), the after-smoking average is slightly greater than the before-smoking There is obvious, therefore, a strong tendency to greater temporal regularity of associative recall after smoking: a tendency to "steadier work." This is in striking agreement with the more uniform efficiency of work in dart throwing found after smoking.

Other points in regard to the details of associative recall may be worked out from this data, but this must be done later, since the elaboration will be very tedious. We shall be interested in the repetitions, not only of words (which is a minor matter), but of ideas expressed in variant words. It is possible, for example, that there is a greater, or a less tendency to repetition before than after smoking. The monotony or variety of themes about which the ideas are grouped, and the relative predominance of analytic or of synthetic associations also remain, among other factors, to be worked out from the data accumulated.

The important caution with regard to the interpretation of the data presented concerns the lack of control series. While it is true that the associative recall after smoking is characteristically different from the recall before smoking, that does not prove that the difference is due to the smoking. Control series must be run under exactly the same conditions, with the same interval between first and second tests, but without smoking. Although, in view of the long resting period before the first test, it is highly improbable that the differences shown in the second tests are due merely to the further resting period between the first and second tests, yet we can not at present say that it is not possibly the case.

Further work is necessary, not only in extension of tests to a larger number of individuals, but also in placing of the tests at different periods of the smoking process. What we should have found if the second test had been given sooner after the beginning of smoking, or later, we cannot infer. So far, we have merely established and demonstrated a method, and demonstrated that at least the (alleged) pernicious effects of smoking upon free associative thinking is not readily demonstrable.

In addition to the work of free association, a rather extensive investigation of controlled association was made on nine individuals with the Johns Hopkins chronoscope and voice key apparatus. The results of this work are technically interesting, but are not ready for immediate presentation. The conditions in controlled association are, of course, radically different from those of free association, and not directly comparable with them.

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VITA

Robert Lee Bates, the son of William G. and Susan (Smith) Bates, was born at Middleway, Jefferson County, West Virginia, November 7, 1886. He received his primary and secondary education in the public school and Jefferson Academy at Middleway. He was a student at the University of West Virginia during the years 1906–1908, 1910–1912, and 1913–1914, and several summer sessions, receiving the degrees of LL.B. in 1912, and A.B. in 1916, and also completing the four years course in the West Virginia School of Military Science.

He spent the years 1918–1921 in graduate work in the Johns Hopkins University, receiving the degree of A.M. in 1920, and being Research Fellow in Psychology during the year 1920–1921.

He has held teaching and professional positions as follows: 1905–1906, teacher in the elementary public schools of Kabletown District, Jefferson County; 1908–1910, Principal of the Hedgesville High School, Berkeley County; 1914–1916, Principal of the Moorfield High School, Hardy County; all in West Virginia. 1916–1918, Principal of the Chesapeake City High School, Maryland. February 22, 1918, to November 12, 1919, in Military Service, in training at Camp Greenleaf; Personnel Work at Camp Forrest; in charge of psychological work in the mustering in of recruits at Camp Lee; Supervisor of Class Room instruction in Hospital School, Secretary to Board of Claims for lost baggage, and Naturalization Officer at Fort McHenry. Commissioned 1st Lieutenant in the Sanitary Corps.

Since September, 1921, he has been Adjunct Professor of Psychology in the Virginia Military Institute, Lexington, Virginia; and head of the Department of Psychology since 1922.

The research on which this dissertation is based was carried out during the year 1920–1921 and summer of 1921, under the direction of Dr. Knight Dunlap.